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BY THE SAME AUTHOR.

A

PRACTICAL TREATISE

ON

THE MECHANICAL CONTRIVANCES EMPLOYED FOR THE RELIEF AND CURE OF HERNIA.

WITH NUMEROUS ENGRAVINGS.

Pp. 112. 3s.

Preparing for the Press.

A MANUAL

ON

THE MECHANICAL TREATMENT OF CURVATURE OF THE SPINE,

AND OTHER DEFORMITIES OF THE TRUNK AND UPPER EXTREMITIES.

Copiously Illustrated by Photographs and Mechanical Drawings.

ON

THE MECHANICAL TREATMENT

OF

DEFORMITIES AND DEBILITIES

OF THE

LOWER EXTREMITIES.

PLATE I

Fig 1

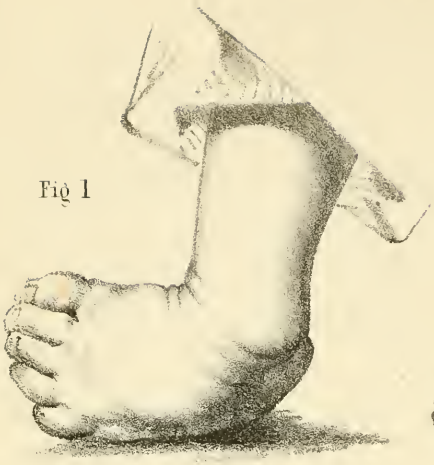

Fig 2.

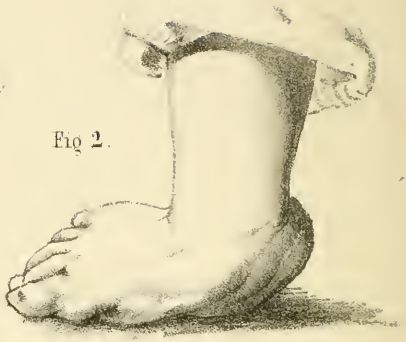

Fig 3

Fig 4

Fig 5

S. Moreton del.

T. Underwood lith.

A TREATISE

ON

DEFORMITIES AND DEBILITIES

OF THE

LOWER EXTREMITIES,

AND THE MECHANICAL TREATMENT EMPLOYED IN THE PROMOTION OF THEIR CURE.

ILLUSTRATED BY COLOURED DRAWINGS OF THE MUSCLES AND TENDONS OF LEG AND FOOT, LITHO-PHOTOGRAPHS OF CASES, AND NUMEROUS WOODCUTS

OF

THE MOST APPROVED MECHANISM EMPLOYED.

S
501

BY

T. P. SALT, BIRMINGHAM,
ANATOMICAL AND ORTHOPÆDIC MECHANICIAN,
AND AUTHOR OF
"A PRACTICAL TREATISE ON THE MECHANICAL CONTRIVANCES EMPLOYED FOR THE RELIEF AND CURE OF RUPTURE."

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TO

W. J. LITTLE, M.D.,

FOUNDER OF THE ROYAL ORTHOPÆDIC HOSPITAL,

IN ACKNOWLEDGMENT OF

THE ABILITY, ENERGY, AND ZEAL WITH WHICH HE HAS DEVELOPED

THE SCIENCE OF ORTHOPÆDY,

AND OF

THE VALUABLE INSTRUCTION AFFORDED BY HIS WRITINGS

TO THE ORTHOPÆDIC MECHANICIAN,

THIS WORK IS

(WITH PERMISSION)

Respectfully Dedicated,

BY

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PREFACE.

This treatise consists of two parts, the first is devoted to preliminary matter and the anatomy of the parts concerned in the deformities treated of; the second to the description of the individual classes of deformity, and the mechanical treatment suited to each.

The work is illustrated by coloured drawings, litho-photographs of cases treated according to the principles enunciated in the text, and numerous woodcuts of the mechanism generally employed.

The woodcuts represent the mechanical apparatus referred to in the body of the work. Every approved apparatus has been adopted, whether of English or foreign manufacture; in many instances improved modifications will be apparent, and a large number of original contrivances are exhibited.

The photographs of cures might easily have been

multiplied almost to any extent, but those selected are types of all varieties, and will sufficiently demonstrate the possibility of relieving even the most severe cases.

A peculiar characteristic of this book is, that each apparatus is so carefully drawn as clearly to show its construction, thus enabling the surgeon to judge of its merit, and to see that what he requires, by whomsoever manufactured, is correct in principle and correctly carried out in detail.

The above plan has been adopted with the view of collating and arranging as an exhaustive treatise all possible information on the subject of deformities of the lower extremities; so that the work may prove a valuable handbook to the surgeon, and especially to the student of orthopædy. As the work may probably be consulted by the non-professional as well as by the professional reader, the Author will be excused by the profession for appending a glossary of some of the more technical terms employed.

The anatomical plates are from original drawings by Mr. Moreton; the photographs are by Mr. Pickering; the lithographs and litho-photographs by Mr. Underwood; the mechanical drawings by

Mr. W. T. Foulkes, and their transference to wood by Mr. Sershall, all of Birmingham.

The anatomical details are collated chiefly from Mr. Gray's "Descriptive and Surgical Anatomy," and Erasmus Wilson's "Anatomist's Vade Mecum."

To these and the other authorities consulted, from whom much valuable information has been gleaned, the Author's acknowledgments are due, especially to Dr. Little, Mr. Brodhurst, Mr. Barwell, and Mr. Bigg; and to the artists whose careful attention has been devoted to the illustrative drawings, thanks are also due.

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NOTE.—The whole of the original photographs and casts from which the illustrated cases were taken, are, with many more, in the possession of the author, and may be inspected by any one taking an interest in the subject.

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CORRIGENDA.

p. 27, line 9, *for* "development," *read* "thickening."

,, 27, ,, 16, *for* "strumous," *read* "cachectic."

,, 97, ,, 11, *for* "variations," *read* "deviations."

,, 167, ,, 27, *for* "aligned," *read* "applied."

,, 168, ,, 2, *for* "gracilis," *read* "gracilis and psoas and iliacus."

,, 174, ,, 1, *for* "semimembranosus," *read* "semimembranosus and biceps."

ON

DEFORMITIES AND DEBILITIES

OF THE

LOWER EXTREMITIES.

INTRODUCTION.

The object of this book is to describe the nature, causes, and mechanical treatment of the various deformities incident to the lower extremities of the human body; the large number of persons who are sufferers, more or less, from the maladies referred to, invests the subject with paramount importance.

The books which have been written are not numerous, nor are they quite calculated to satisfy the person who reads with the view of turning to practical account the knowledge acquired; that which has been written is chiefly on the pathology of deformity and instruction respecting operations. The subject has not hitherto been treated as a whole—that is, as a consideration of the causes of

deformity, and the mechanism employed in its treatment and cure. Medical men are frequently at a loss to know the most suitable contrivances to adopt in special cases, owing chiefly to the indistinctness with which all the mechanical apparatus have heretofore been drawn and described; to the patient himself no information has been given, and no instructions, by the application of which he may assist the surgeon and mechanician in carrying out their views, and from the absence of which a cure is retarded, and in not a few instances altogether prevented. It is hoped that the wants thus indicated may be supplied by this volume.

Cases often come under the notice of each orthopædic mechanician differing in some way from any previously described, and requiring some modification of the apparatus ordinarily employed, the history and description of which may prove invaluable; such as have come under the author's observation (not a few during the last twenty-five years) are described with accuracy, and in addition to this every approved contrivance, whether English or foreign, has been carefully examined, clearly explained, and illustrated.

A brief chapter is devoted to the history of the rise and progress of mechanical therapeutics, and the introduction of tenotomy into England, which

has given so great an impetus to the orthopædic mechanician's art.

The author is indebted to the Medical profession generally for many valuable suggestions which have enabled him to carry his experiments to a successful issue, and to them he tenders his warmest acknowledgments.

PART I.

CHAPTER I.

Necessary Qualifications of an Anatomical Mechanician—Practical Knowledge of Mechanics and of Anatomy essential—Examination Test for the Mechanician—Advantage to the Surgeon—History of Orthopædy—Early Advanced Ideas—Their Loss—Hippocrates—The Correctness of his Opinions—Succussion—Extension—Explanation of Mellet's Apparatus—Pressure on the Extruded Vertebræ—Fallacy of these Modes of Treatment—Loss of the Labours of Hippocrates—Long Interval in which no Advance was made in Orthopædic Science — Paré — Hildanus — Glisson — Arcæus—Mincius—Andry—Continued Employment of Empirical Modes of Treatment—Scarpa and his Shoe—Discovery of Tenotomy—Its Progress—Dr. Little introduces it into London—The Royal Orthopædic Hospital established—General Recognition of the Importance of mechanical Treatment in Orthopædy.

The province of the therapeutic mechanician has become of late widely different from what it formerly was; the steady advance of science has not left this important branch of study behind, and the treatment of deformity with a view to cure now receives an amount of attention commensurate with its importance. This is due partly to the introduction of tenotomy, which opened out a wide field for investigation and experiment, and partly to the growth of a fuller appreciation of the value of the various mechanical forces which might be employed for the relief of deformity.

However this may be, the progress of science obligated a corresponding advance in the acquirements of the mechanician, who, from a mere uneducated workman, became a man of liberal education. In former days, before orthopædy had become a separate and distinct branch of study, and the introduction of tenotomy had rendered curable many cases which previously were considered hopeless, nothing more was required of the "instrument maker," as he was rightly called, than merely to carry out the instructions of the surgeon under whose orders he acted. Now, however, it is far otherwise; the surgeon having diagnosed and treated the disease, leaves the mechanical part of the treatment of deformity mainly in the hands of the orthopædic mechanician, who, to secure success even in a moderate degree, must acquire a knowledge of at least so much of anatomy as relates to the parts implicated in the various deformities with which he has to contend; he must also be conversant with the theory and principle of applied mechanics; he must understand the action of the screw, the lever, and other forces which he will have to apply in the construction of orthopædic apparatus, or the result will be injury to the patient instead of benefit. In addition to all these qualifications, he should have gained in early life a practical acquaintance with the manufacture of the

needful apparatus; for although it may not be necessary for him afterwards to undertake the manual part of his profession, nevertheless the knowledge thus acquired enables him the better to direct the efforts of those in his employ, so as to carry out efficiently the designs originated by the surgeon and himself.

Finding these new demands upon his skill, the mechanician exerted himself to meet them, and it is interesting to observe the progress he has made in the acquisition of knowledge; a brief review of the history of orthopædy may be interesting, and here I shall not, perhaps, be considered out of place in observing, that it is to be regretted that orthopædic mechanicians are not required to pass an examination embracing a general view of anatomy, especially of osteology and myology, and an exact knowledge of the principles and application of practical mechanics, before being recognised as competent to exercise their art; the dispensing chemist and the dentist are obliged to pass through this ordeal, and the surgeon surely depends as much upon the man to whom he entrusts the mechanical treatment of deformity, either after he has performed a surgical operation, or without that assistance, as upon him who dispenses his medicines.

The surgeon would derive much benefit from such arrangement, inasmuch as he would feel confident when recommending his patient to a duly

certificated mechanician, that he was sending him to a man of skill, and one who would be able to apprehend and carry out any idea suggested by himself, or personally to originate, construct, and apply, the mechanism most suitable to the case under treatment.

To revert to the history of orthopædy; in this, as in every other study, the first ideas formed were crude and unsatisfactory; yet, as is frequently the case, in the midst of the most absurd hypotheses, opinions were broached which, although ignored and lost sight of for ages, are now held to be true; and men were found, who in their knowledge of the principles of their science, in the correctness of the deductions drawn from that knowledge, and in the facility with which they applied them, were centuries in advance of their contemporaries.

Unfortunately, however, much of this knowledge, gained with such labour and perseverance, was lost to the world either through indifference or wilful blindness, only to be revived in after ages as novelty.

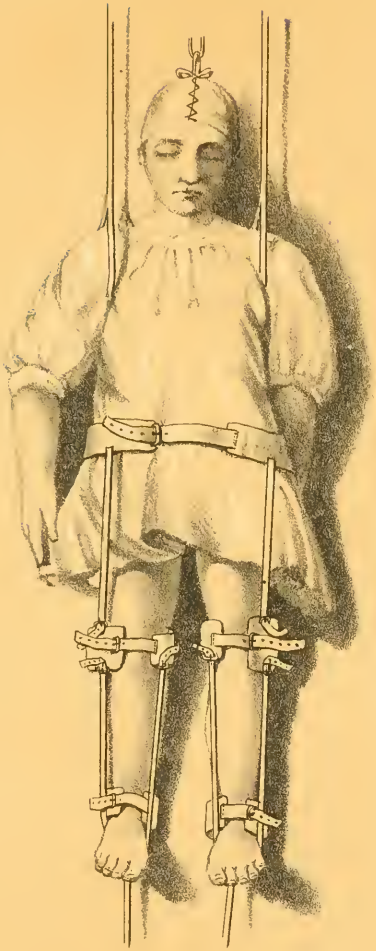
In no science has this fact been so aptly exemplified as in that of surgery, so far as it relates to the treatment of club-foot and other analogous deformities. Five hundred years before the Christian era, Hippocrates carried the science of medicine, surgery, and especially of orthopædy, to an

extent of usefulness not afterward exceeded, nor even attained for the space of nearly two thousand years. The correctness of his opinions in reference to club-foot especially, has been completely confirmed by the experience and research of modern times; he also combated the fallacious views then prevalent, that spinal deformity was curable by the employment of brute force; for example, it was customary then, and for centuries afterwards, to attempt the correction of projections of the spine by means somewhat similar in principle to those which are now employed to reduce dislocations, namely, by suspending the body from a ladder or on an inclined plane, or couch, with the head or the feet upwards, as the distortion happened to be in the upper or lower part of the back, thus allowing the entire weight of the parts below the point of suspension, to drag upon the displaced vertebræ, hoping thus to compel them to reassume their normal position.

The accompanying curious drawing (Plate II.), taken from Mellet's work on "L'Orthopédie," will explain more clearly the method of suspension on an inclined plane; from Mellet also, I extract his explanation.

"L'extension y est exercée supérieurement par une courroie tenant à une serre-tête, et mise en jeu par une espèce de treuil muni d'un cliquet, et par des

PLATE II



I Underwood lith

liens placés sous les aiselles, et inférieurement par une ceinture semblable en quelque sorte à celles qu'on emploie aujourd'hui, mais, qui embrassait en même temps la cuisse au-dessus du genou, et la jambe au-dessus des malléoles par des courroies matelassées; 'au moyen de quoi,' dit Venel, 'l'action extensive, étant partagée, est moins incommode, ou plutôt, est très supportable, comme une longue expérience me l'a prouvé."

In addition to this, a still more objectionable method was frequently employed; the patient was made to stand, or was suspended in a recess in a wall of such size as would only admit the body in its normal or undeformed position, thus leaving the projection or hump visible in profile; upon this hump a lever was brought to bear, whose fulcrum was a staple let into the wall on one side of the recess; a pad was interposed between the lever and the back to prevent abrasion, and considerable force was exerted.

A very little consideration will show how fallacious were the ideas upon which this mode of treatment was based. The whole weight of the upper or lower half of the body, as the case might be, straining upon the spine, aided by heavy weights (which were sometimes attached to assist in the extension), might possibly have some tendency to extend the vertebral arch, but with

this apparent improvement would be produced such a state of weakness of the parts as would readily admit of a relapse, and the last state of the deformity would be worse than the first.

Some slight appearance of reason, however, surrounds this mode of treatment, which was called succussion, and relieves it from some of the absurdity attaching to the plan with which it was usually connected, namely pressure on the apex of the projection by means of a lever, manual force, or otherwise.

The result of powerful and continued pressure on this point would be, not the reduction of the original arc of deformity, but its transference from a posterior to a lateral curvature, which latter would be subject to all the aggravations attendant on sudden and violent alteration in the position of parts so complex, and containing so many articulations as the spine.

In addition to these evils, in themselves sufficient to condemn such a practice, dislocation or fracture would be quite as likely to occur as reduction even in lateral deformity, but as Hippocrates very justly observes, "if men see a great deal of outward show, they wonder at and admire the means employed, but trouble themselves very little to inquire the result obtained;" hence these empirical operations attracted much attention and

were greatly commended during a long series of years.

I have before remarked that the opinions of Hippocrates on the subject of club-foot received but little consideration for ages after his death, and the mode of procedure recommended by him for the treatment of deformity did not greatly vary in principle from that now employed; but only in the mechanical ingenuity with which it is applied. The benefit of the industry and perseverance of this talented and far-seeing man, perished with his life, and, for a period of nearly two thousand years, there was a perfect blank in the history of mechanical therapeutics, in which not only were no improvements made, but an actual retrogression took place.

Ambrose Paré, in the seventeenth century, was the next who rose to any considerable eminence, and to him we owe the first volume (after Hippocrates) which explains, with any degree of accuracy, the science of medicine or the practice of surgery. His views were in many cases sound, and he left to the world much valuable information, especially on the subject of mechanics as applied to surgery, which has proved of eminent service to the practitioners of a later day.

After Paré followed others who directed much of their attention to the study of orthopædy, and

introduced in the construction of mechanical supports for deformity, first the screw, and afterwards the lever, as some of the most powerful and useful curative means to be employed.

Fabricius Hildanus, Glisson, Arcæus, Mincius, Andry, and Scarpa, are the men whose names are best known as earnest students of this branch of surgical science. Glisson employed a corset for spinal deformity. Arcæus used a wooden shoe with lateral wooden uprights for the cure of club-foot; whilst Scarpa has earned for himself a world-wide reputation by the invention of the famous shoe which bears his name, for many years the only instrument used in the treatment of club-foot, and which is acknowledged to have suggested the principle upon which many of the more elaborate and scientific instruments now in use for the same purpose were constructed.

Much, however, as these pioneers in science did, in their day, to place orthopædy on its proper basis as a distinct branch of study, they did not do all; they did not adequately recognise the value and importance of that primary axiom in mechanical therapeutics, "that nature may be led by the hand, but can never be pushed by the shoulder;" we may guide her but can never drive her; hence they fell very frequently into similar errors to those which they condemned in the ancients, viz., the

employment of empirical means for correcting deformity, and attempting its cure by the sudden and violent, instead of by the gentle, gradual, and rightly-directed application of mechanical force.

It was not until some years after the great discovery of subcutaneous tenotomy by Stromeyer in 1830, that this fact began to be fully and completely understood; and considering how great an influence has been exercised by tenotomy on orthopædy, a short notice of its rise and progress may not be uninteresting.

From the works of Hippocrates, published by the Sydenham Society, we find that the subject had been considered by him; but whatever may have been his views, and those of the ancients generally, it is quite certain that no deep impression was made on the minds of the Medical Profession, for we hear nothing more until the seventeenth century, when the subject was investigated with patience and zeal by several distinguished surgeons, chiefly Germans; amongst others by Severinus (in 1643), by Paré (1641), and later still by Arcæus (1658).

In the eighteenth century we find still greater attention given to tenotomy; commencing with Du Verney (1751), we have Venel, Verdier, Blumenbach, Wanzel, Naumberg and others, all

distinguished men; still no very important advance was made by their researches, and indeed, much diversity of opinion existed between them as to the causes of distortion, with no greater agreement as to the treatment required. For example, Du Verney assigned muscular retraction as the cause of club-foot; Naumberg and Blumenbach attributed it to malposition of the tarsal bones. Palletta asserts that the total or partial deficiency of the inner malleolus is the primary cause of Talipes varus; Rudolphi, that "club-foot in the fœtus arises alone through morbid nervous influence acting on the muscular system;" and Cruveilhier that the deformity was induced by a cramped position *in utero.*

The first recorded operation for club-foot was performed at Frankfort by Thilenius in 1784, and appears to have been successful. Twenty years afterwards, a second operation, performed by Sartorius (1806), was also successful; after which Michaelis operated for talipes eight times in the years 1809-10.

Delpech comes next in order (1816), who, although he wrote four rules for observation in tenotomy, which even at the present day are in force, nevertheless, himself performed but one operation.

In 1831, Stromeyer first *subcutaneously* divided

the tendo Achillis, and the Medical Profession, in this country at least, cede to him the reputation of having placed tenotomy on a firm basis as a part of surgical art; it must be further borne in mind that Stromeyer simplified the operation, and improved the mechanism employed for after-treatment, of which, for the first time, we have much account. Four years afterwards, the operation was introduced into France on Stromeyer's method by Duval.

In 1836, Dr. Little himself submitted to a successful operation at the hands of Stromeyer. In 1837, he wrote an inaugural dissertation on Talipes varus and founded the Royal Orthopædic Hospital. Since that period until very recently, the practice of tenotomy has rapidly extended, being introduced into private as well as hospital practice; lately, however, a theory has been mooted opposed to the present received and adopted views, and condemning tenotomy altogether, and as it is broached by a very able surgeon (Mr. Barwell) it is worthy of careful investigation; be this, however, as it may, it is quite certain that tenotomy gave an active stimulus to the orthopædic mechanician to laborious thought and careful experiment, inasmuch as he saw a much wider field opened for his labours by the successful efforts of tenotomists.

From the introduction of tenotomy dates an

entirely new era in the history of mechanical therapeutics. The operation was not designed as a substitute for the instrumental treatment of deformity, but as a means of rendering its success more certain; from the satisfactory results thus obtained, the great value of scientifically designed and carefully constructed apparatus for the cure of distortion was firmly established, and universally recognised by the Medical Profession, and the study of the principles upon which their operation was based, was earnestly pursued until the art of the orthopædic mechanician was brought to its present state of perfection.

CHAPTER II.

Causes of Deformity—Congenital and Non-Congenital—Causes of Congenital Talipes—Malformation of Tarsal Bones rare—Spinal and Cerebral Affections, the ultimate Cause—Paralysis of one Set of Muscles and Preponderance of another, the proximate Cause—Mr. Barwell's Opinion—Causes of Adult Talipes—Rickets productive of Distortions of the Legs—Causes of Rickets—Dr. Little's Opinion—Characteristics of Rickets—Composition of Bone—Changes which occur in the Formation of Rickets—Signs of impending Rickets—Spinal Deformity produced by Rickets—Time of its Appearance—Medical, Surgical, and Mechanical Treatment required—Deformity not spontaneously curable—Ankylosis—Contracted Joint—Ankylosis partial and complete—Its Causes—External Injury—Strumous Diseases—Contracted Joint—Its Causes—Retraction of Muscles caused by long Splintage, &c.—Cicatrices of Wounds.

Having in the previous chapter briefly traced the history of mechanical therapeutics, its infancy, progress, and recent development, I proceed to consider the causes which, in the opinion of the most eminent orthopædic surgeons, mainly operate in the production of deformity; for convenience of description I have divided the subject into two classes, namely congenital and non-congenital, and following the natural order, will consider first those which are congenital.

One of the causes which would most readily pre-

sent itself to the mind as likely to produce talipes is malformation of the tarsal bones, or absence of one or more of them. It is true that this abnormal condition of the tarsal bones does sometimes take place, almost invariably producing deformity of one kind or another, but it is an event of extremely rare occurrence. It is the opinion of eminent medical men that the primary cause of congenital distortion is to be sought for in a deranged and morbid condition of the brain, the nervous system, and the spinal cord, or in an imperfect development of either. Any deficiency or abnormal condition of these important organs, by means of their intimate connexion with every part of the body, very frequently involves a corresponding abnormal state of the muscles of the limbs; thus, when deficiency of the whole or any part of the brain occurs, it often happens that some of the muscles of the leg and foot are arrested in their development. When this is the case, those which remain healthy exert their greater force and draw the foot away from the affected side, producing talipes varus or valgus, according to the muscles which are implicated in the disease; hence it will appear that the muscles and tendons are only secondary instruments in the formation of talipes, the primary cause being deficiency or change in the nervous system. That every unnatural condition of the spine has much

connexion with the muscles of the leg and foot is proved by the fact that spina bifida is usually accompanied by some variety of talipes.

It being impossible to watch the origin and progress of deformity previously to the period of birth, we can only reason from analogy, and not from observation, so that our inferences have not that perspicuity and certainty which attach to those drawn through the agency of the senses; many hypotheses, therefore, have been advanced, which the more mature judgment and greater experience of later days have proved to be untenable.

Among these may be mentioned mal-position *in utero*, which has been quoted as one of the most frequent—nay, as the only cause of congenital deformity. Mr. Brodhurst, in his excellent work on club-foot, completely disproves this proposition, and clearly shows that if it were true, from the peculiar position of the fœtus *in utero*, packed as it is in the smallest possible space, all the joints being flexed, club-hand and club-foot would be the rule instead of the exception.

I cannot better conclude my remarks on the causes of congenital deformity than by quoting the following paragraph from Mr. Barwell's work on "Club-foot, without cutting Tendons:"—

"The only tenable theory, the only doctrine at all consistent with facts, teaches that club-foot,

both acquired and congenital, is produced by deficient muscular action on the side of the limb from which the foot is drawn. Moreover, it is easily comprehensible that the originally feeble muscles, having been weakened by disease and stretched by the healthy ones, can neither regain their normal length nor power sufficiently to overcome their opponents and replace the foot."

Additional causes may operate in producing acquired deformity besides those which I have described as the agents of distortion in congenital club-foot; these I will now endeavour to explain.

The causes which I have enumerated as tending to produce congenital club-foot operate even in a stronger manner after the period of birth, on account of the increased preponderance exerted by the healthy muscles over those which remain paralysed; their action is, however, identical in both cases; they need, therefore, only be mentioned before referring to a cause which, during infancy, frequently produces very serious deformity—I mean rachitis, or as it is more commonly called, "rickets."

The ordinary forms of distortion produced by this disease are knock-knee (genu valgum), bowed-leg (genu extrorsum), and crooked legs and shins (inflected tibiæ). Talipes never, or very rarely, occurs as a primary result of the rachitic condition,

but is very frequently induced secondarily by the altered and abnormal position of the tibia and fibula relatively to the femur and astragalus.

The chief cause of rachitic weakness is an insufficient supply of food, or the supply of improper food, the result of either of which is mal-assimilation of that which is taken, and consequent impaired nutrition.

Dr. Little says:—"Numerous infants, born perfectly sound, about the period of dentition, or that of weaning, suffer from gastro-intestinal derangement, and in spite of abundance of food, become debilitated, and at the period when children usually attempt to walk, are observed to make no use of their limbs. In these cases, the effect of the gastro-intestinal disturbance is to impair the digestion and assimilation of food, the maintenance of the structure, and the growth of the several parts of the animal economy. Many infants, equally robust at birth, become debilitated as their age increases, in consequence of the poorness of the milk received from the parent, produced either by derangement of health through luxurious and enfeebling habits, and, perhaps, through constitutional debility, as among the rich, or induced by insufficient food and other causes, as amongst thousands of the poorer mothers of this metropolis. Whatever be the remote cause of the debility in

question, the proximate cause, imperfect assimilation of food and impaired nutrition of the frame, is the same."

Here, then, is clearly described the cause of rickets; and it may be observed that there is much truth in the remarks of Dr. Little on the custom of "starving" young children with the intention of preserving them from indigestion and similar evils. He says:—"The fear of mixing the two milks during infancy, and the fear of grossness from animal diet, deter not only the ignorant, but sometimes highly-educated mothers from following the impulses of nature in giving to the young, plain and wholesome articles of diet, of which they would readily partake. The author's opportunities of observation of infants and children in public charities and in private practice have convinced him that from the operation of the above fears, thousands of children are annually starved into rickets, either into the rarer severe forms of the disease (universal rachitis), or the numerous lighter manifestations of it (weak ankles, weak knees, pigeon-breastedness). Even many medical men are influenced by these fears, and in the case of infants, when "artificial" food is compulsory, advise a largely-watered milk or milked water when they should recommend a food containing as great a proportion of animal nutritive matter to the containing

water as human milk does. The younger the infant deprived of the breast, the less is the aptitude to digest and assimilate farinaceous substances, and the greater is the necessity for an amply-sufficient supply of slightly diluted pure and unskimmed milk of a domestic animal." When a more rational idea respecting diet is instilled into the minds of mothers, rachitic distortion will become of rare instead of frequent occurrence.

"The important character of rickets," Dr. Little further observes, "is that of softening the framework of the system; hence a collapse of certain parts, a sinking of others beneath the superincumbent weight, and a liability to alteration from the natural shape through the action of the muscles attached to them."

The osseous parts of the human frame are composed of two distinct elements, the animal and the mineral. It is the animal part of the structure which gives to the bones their flexibility and elasticity, whilst to the mineral part, which in the normal state, is greatly in excess, they owe their stiffness, rigidity, and capability of resisting the superincumbent weight of the body, the power of the muscles, and all forces acting from without. In their natural or healthy conditions, these separate elements of bone are so proportioned as to yield the greatest amount of elasticity and flexibility

consistent with the necessary strength; but when a disturbing influence comes into operation, the equilibrium is destroyed, and the preponderating element exerts its force and determines the consistence of the bone; if the mineral matter be in excess, the bone becomes too hard and brittle, and frequent fractures result; but if, as in the case of rickets, the animal matter predominate, the structure becomes too soft and flexible to sustain the weight thrown upon it, beneath which it falls into a curve, thus producing rachitic distortion of one kind or another.

The precursory signs of impending rickets are a general enlargement of the joints—a flabby and unhealthy state of the flesh, and an abnormally rapid development of some parts to the detriment of the proper nutrition of others; thus the head and abdomen of rickety children are usually extraordinarily large in proportion to the extremities, which, although they may be flabby and bulky, clearly indicate arrested development. This first appearance of rachitis may not at once produce deformity, but will inevitably do so in course of time, unless its progress be arrested by the timely resort to proper means for its relief.

In a later stage of the disease the knees fall, sometimes outwards, but much more commonly inwards, or the tibiæ become bent either laterally

or anteriorly; as a secondary result, the inner or the outer ankle sinks to the ground, and thus a kind of spurious talipes is produced.

The affection of rickets very often produces deformity, not only of the legs, but also of the spine, and that of the most serious character; but as the consideration of this class of distortion is not within the scope of the present work, which treats of the lower extremities only, I merely mention it.

It should be observed that medical and surgical, as well as mechanical treatment, is required for the cure of this affection; with the two former, however, I have nothing to do, as they belong to the province of the physician and surgeon, with which I do not presume to interfere. The disease usually makes its appearance at about the age of twelve or fifteen months, very rarely, or never, after the completion of the second year.

Before leaving the subject of rickets, considered as a cause of deformity, I could wish to say a word in opposition to the too frequently received opinion that children will "grow out" of the distortions induced by this disease; I am of opinion that deformity is *never spontaneously curable.* On this subject Dr. Little says: "I have been consulted concerning many patients with the highest grade of this affliction (rachitic curvature of the leg bones), in whose early infancy their parents were assured

the 'weakness' and deformity would spontaneously subside; that the children would 'grow out of it.' I advise you not implicitly to trust to nature in these cases; when once the straight line of the limb is, to any considerable extent, destroyed by this inward curvature of the knees, the assistance of art is imperatively required for its relief."

Genu valgum is sometimes produced by excessive standing in one position. Deformity thus induced is not common, but where it does occur, it is usually found in youths of from ten to eighteen years old.

I now pass on to consider the causes which operate in producing ankylosis or stiff joint, and contracted joint; these are numerous, but as many of them involve much anatomical detail, I shall not do more than briefly mention them.

Ankylosis, or stiff joint must be carefully distinguished from contracted joint; the former may occur with the limb either in a straight or a flexed position, the joint being perfectly rigid and immovable, permitting neither of flexion nor extension; the latter necessarily occurs with the limb flexed to a greater or less extent, but, differing from the condition of ankylosis, although it cannot be extended beyond a certain point, it may be flexed so as to form a smaller angle with the limb to which it is articulated, returning on the removal of the

influence of the flexor muscles, or of extraneous force, to the limit of extension permitted by the contraction. I will speak first of ankylosis.

This disease of the joints is divisible into two grades, partial or false, and complete or true ankylosis: true ankylosis is distinguished by complete osseous union of the articular surfaces of the opposing bones, whilst false ankylosis is characterized by an abnormal development of the ligaments and by a large deposit of lymph in the intra-articular spaces, which impedes, or rather prevents the motion of the joint.

These deformities are produced by inflammation in the articular region, whether caused by severe external injury, or by scrofula, rheumatism, or strumous diseases of any kind; the severe pain experienced in such cases in the attempt to move the joint, which is the seat of disease, assists the progress of the deformity by causing the limb to be maintained constantly in one position, usually that of flexion, thus predisposing the flexor muscles of the limb to become structurally shortened, so that when the inflammation subsides, their contractile power very frequently aids the lesions caused by the inflammation to retain the limb in its stiff and ankylosed condition.

Foremost among the influences which produce contraction as opposed to ankylosis, stands retrac-

tion of the flexor muscles and their tendons; this is very frequently occasioned by the limb being confined for a lengthened period, as after fracture or dislocation in the flexed or semi-flexed position by means of angular splints. The muscles adapt themselves to the position in which they have been constantly retained, the extensors becoming elongated whilst the flexors are correspondingly shortened, and when the splint is removed it is often found that the limb cannot be straightened, although it may be flexed still further. Other very frequent causes of contraction are the large cicatrices which frequently form in the neighbourhood of joints after burns, wounds, or scrofulous diseases; these, by approximating the tissues above and below the joint, flex the limb, and by retaining it thus, eventually produce muscular retraction also. This is almost invariably followed by atrophy, or wasting of the tissues, and a diminution of temperature as an approach is made from the other parts of the body to the seat of the disease.

CHAPTER III.

Review of last Chapter—Plan of Anatomical Part of the Work—Division into Osteology and Myology—Osteology—The Uses of Bones—Their external and internal Appearance—Composition of Bone—Its internal Nutritive Arrangement—Division of Bones into Classes—Long Bones—Short—Flat—Irregular—The Periosteum—Ossification of Bones—Number of Bones in the Skeleton and in the Lower Extremities—Articulations—Definitions—Variety of Articulations—Subdivisions of Movable Joints—Gliding Movement—Angular Movement—Circumduction—Rotation—Peculiarities of Articular Surfaces of Bones—Cartilage—Synovial Membrane—The Femur—Its Articulation—The Patella—The Tibia—The Fibula—Their Articulations—The Astragalus—Its Articulation—Os Calcis—Cuboid—Scaphoid—Cuneiform Bones—Metatarsal Bones—The Phalanges—Their Articulations.

Having in the previous chapters given some account of the history of mechanical therapeutics, its rise, progress, and present position, and enumerated the various conditions which, in the opinion of the best modern orthopædists are productive of deformity, I proceed to give a brief account of so much of the anatomy of the parts implicated, as is necessary to enable the reader to obtain some idea of the mode of operation of the causes referred to, and of the alteration in the shape and position of the parts induced by their action.

The subject may be conveniently divided into

two heads, namely, osteology, or the consideration of the bones forming the skeleton, their connexions and articulations; and myology, or the description of the muscles with their tendons and their action. Under this last title I shall also consider the fasciæ, as they, although not coming under the same anatomical denomination, are yet very intimately connected with the muscular system, and contribute with the muscles to produce many kinds of deformity; and as this work is not intended as a scientific anatomical disquisition on the parts, but merely as such an account of them as is needful to render the subsequent matter clear and intelligible, I may, perhaps, be excused for departing slightly from the scientific order of procedure in order that I may treat the subject in such a manner as may best illustrate the character of the maladies under consideration.

The purpose which bones are destined to fulfil in the economy of the human body is to give support and convenient arrangement to the softer parts, and to form as it were a framework, by the aid of which they may be suitably built up into a complete edifice.

In order to the more perfect fulfilment of this object, the substance of which bone is composed is so arranged as to offer the greatest possible resistance to the impact of external force and to super-

incumbent pressure, and at the same time to combine with this essential solidity the greatest attainable lightness. To this end bone presents externally a firm, compact, and almost solid surface of fine texture, suitable to resist force or to sustain weight; internally, however, the structure is more open and lattice-like, by reason of which it is called cancellous tissue.

Bone consists, as I have before mentioned when on the subject of rickets, of an animal and a mineral element. Of these, in the normal state, the mineral principle makes up two-thirds, or 66·7 per cent., of the whole substance of the bone, the remaining 33·3 per cent. consisting of animal matter.

With a view to the complete nutrition of the bone, every part of it, except those portions upon which the articular cartilage is supported, is penetrated by numerous vessels, by means of what are called "Haversian canals." These consist of very minute tubes, surrounded by lamellæ, or concentric layers of bone. They (the lamellæ) contain small cavities called lacunæ, from which proceed the canaliculi, which are extremely minute vessels which by their ramifications supply the whole of the bone with the elements necessary for its nutrition. Blood is supplied to bones by arteries which enter them at different parts of their surface, and are distributed throughout every portion of their substance.

Bones are divided into four classes, according to their shapes. These divisions are long, short, flat, and irregular bones. Long bones are hollow cylinders, containing within them the medullary canal. They are of very great strength and thickness, and more compact in their substance than any other parts of the skeleton. They are found almost exclusively in the limbs, where they form the passive agents of motion. Instances of long bones in the lower extremities are the femur, the tibia, the fibula, the metatarsal bones, and the phalanges.

The short bones are intended to confer strength, instead of mobility. They consist of cancellous tissue, with an outer layer of compact substance. Examples of them are found in the tarsal bones of the feet.

The flat bones are designed as protection to those parts more especially liable to injury, and appear as broad osseous expansions, or tables, as they are sometimes called, covering some vital part. Their structure is the same as that of the short bones. The bones of the skull and the ossa innominata, or hip bones, belong to this class.

The irregular bones are those which, from their peculiar shape, it is impossible to class under either of the above denominations. They also consist of cancellous tissue, surrounded by a layer of firmer consistency. There is no instance of an irregular bone in the lower extremities.

All bones are surrounded, except at their articular surfaces, by a thin delicate membrane, called the periosteum, which serves as a medium for the introduction of vessels, and as a means of communication between the vessels of the exterior and those of the interior of the bone. A similar but more delicate membrane lines the internal cavities, or medullary canals, of all the long bones.

At the period of birth but few of the parts afterwards destined to become bone are ossified. They remain in a semi-cartilaginous or "gristly" state, if I may be allowed the expression, until some considerable time has elapsed after their first formation. Neither do they ossify simultaneously, nor in the same manner; some commence the hardening process from their centres, whence it extends to the circumference; others have two, three, or more centres of ossification, the emerging radii thrown out from which coalesce, when, at different periods of life, they come in contact with each other. Complete ossification of all the bones in the human body does not commonly occur until about the conclusion of the twenty-fifth year.

The entire adult skeleton consists of two hundred bones, no less than sixty-two of which are contained in the lower extremities; hence the complication and importance of these parts.

The structure and general physical properties of

bone having been described, it remains to consider the form, position, and mutual relations of the several bones which make up that part of the skeleton forming the thigh, the leg, and the foot. Before doing so, however, it will be necessary to explain the structure and arrangement of articulations generally.

An articulation may thus be briefly described:—it is the approximation or contact of parts of the surfaces of two bones, which at their point of contact are held together and kept in apposition by means of tough fibrous structures called ligaments, which surround the joint, as it were, with a capsule, the firmer bands of the ligamentous material being placed at the sides (lateral ligaments), and at the front and back (anterior and posterior ligaments). Under ordinary circumstances these ligaments protect the joint from dislocation.

The forms assumed by the articular surfaces of bones vary greatly according to the character and extent of the motion required in the joint of which they form a part. Thus articulations are divided into three classes, according to the amount of mobility permitted to them; these classes are:—

1. Synarthrosis; immovable joint.
2. Amphiarthrosis; mixed joint.
3. Diarthrosis; moveable joint.

These primary classes are again subdivided into minor divisions; but as my subject has no connexion with any but the moveable joints, it will be unnecessary to mention any subdivisions but those of that class.

In explanation of these subdivisions I cannot do better than extract verbatim a portion of Mr. Gray's excellent plan of the articulations. Speaking of moveable joints, he thus arranges them:—

DIARTHROSIS OR MOVEABLE JOINT.

"Arthrodia, gliding joint: articulations by plane surfaces which glide upon each other, as in sacro-iliac and pubic symphyses. (And tarsal bones).

"Enarthrosis, ball and socket joints: capable of motion in all directions; articulations by a globular head received into a cup-shaped cavity, as in hip and shoulder joints.

"Ginglymus, hinge joint: motion limited to two directions, forwards and backwards; articular surfaces fitted together so as to permit of movement in one plane, as in the elbow, knee, and ankle.

"Diarthrosis rotatorius: articulation by a pivot process turning within a ring, or a ring around a pivot, as in superior radio-ulnar articulation and atlo-axoid joint."

Mr. Gray explains the different kinds of movements admissible in joints as follows:—

"The movements admissible in joints may be divided into four kinds: gliding, angular movement, circumduction, and rotation.

"Gliding movement is the most simple kind of motion that can take place in a joint, one surface gliding over another; it is common to all moveable joints; but in some, as in the articulations of the carpus and tarsus, it is the only motion permitted. This movement is not confined to plane surfaces, but may take place between any two contiguous surfaces, of whatever form, limited by the ligaments which enclose the articulation.

"Angular motion occurs only between the long bones, and may take place in four directions: forwards or backwards, constituting flexion and extension; or inwards and outwards, which constitutes abduction and adduction. Flexion and extension are confined to the strictly ginglymoid or hinge joints; abduction and adduction combined with flexion and extension are met with only in the most moveable joints, as in the hip, shoulder, and metacarpal joint of the thumb, and partially in the wrist and ankle.

"Circumduction is that limited degree of motion which takes place between the head of a bone and its articular cavity, whilst the extremity and sides of a limb are made to circumscribe a conical space, the base of which corresponds with the inferior

extremity of the limb, the apex with the articular cavity. This kind of motion is best seen in the shoulder and hip joints.

"Rotation is the movement of a bone upon its own axis, the bone retaining the same relative position with respect to the adjacent parts as in the articulation between the atlas and axis, where the odontoid process serves as a pivot around which the atlas turns, or in the rotation of the radius upon the humerus, and also in the hip and shoulder."

Since there is no instance in the lower extremities of a rotatory articulation (if we except the hip, which possesses somewhat of the power of rotation, but is properly a ball-and-socket joint,) it will be seen that our further examination may be confined to the three former subdivisions; although indeed the few additional remarks necessary to be made on this subject apply almost equally to every kind of articulation.

The articular extremities of all long bones are formed of a tissue much firmer and more compact than the general structure of the bone. This solid substance is coated with a layer of cartilage, an elastic material susceptible of high polish, which serves by its elasticity to break the force of concussion, and by its smoothness to facilitate the movements of the joint. In aid of this latter

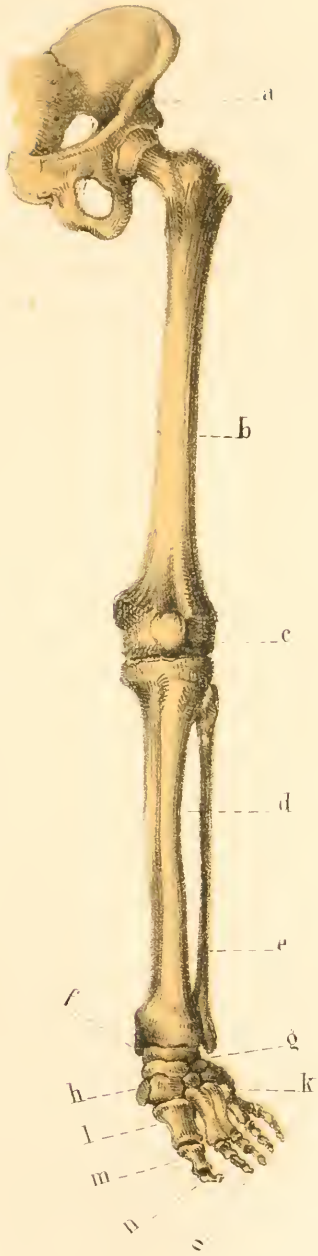
object was designed the synovial membrane, which assumes the shape of a short tube, open at both ends, secreting a lubricating fluid which flows over the joint surfaces. Thus every mechanical requisite for the free action of the joints is provided, and they are ready to be put in motion by the impulse of the will, acting by the contraction of the muscles.

We have described the properties common to all bones, and examined the different modes in which they are articulated with each other. It is now necessary to describe separately the individual bones of which the lower extremities are composed, and in order to do this intelligibly it will be well to divide them into three groups: the bone of the thigh, the bones of the leg, and those of the foot.

The thigh being destined to support the whole weight of the trunk of the body, is furnished with one proportionately large and powerful bone. This is the femur (*b*, in the drawing, Plate III.), the longest and strongest bone in the skeleton. It consists at its upper extremity, of a rounded head, supported upon a short massive neck, uniting with the shaft at an obtuse angle; at the upper part of the shaft of the femur, near and external to its junction with the neck, there is a large tuberosity called the great trochanter, which serves to afford a point of attachment to some muscles, and to give

PLATE III

Fig 1



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increased leverage to others. Nearly opposite to the great trochanter, on the under surface of the neck, is a smaller protuberance, called the lesser trochanter, which is designed to fulfil similar purposes to the great trochanter.

The shaft of the femur is nearly cylindrical, and of great strength and thickness; at its inferior extremity it presents two large processes projecting downwards, divided posteriorly by a deep notch. These are called the condyles (κονδυλος, a knuckle.) On the posterior surface of its shaft, the femur is strengthened by a sharp ridge, continued down its whole length, bifurcating above and below, and called the linea aspera.

The rounded head of the femur is united by means of a ball-and-socket articulation to a cup-shaped cavity in the os innominatum or hip and ischiatic bone (*a*, Plate III.) called the acetabulum; this is one of the most moveable joints in the whole frame, permitting flexion and extension, abduction and adduction, circumduction and rotation. It is held in position by the capsular, ilio-femoral, teres, cotyloid, and transverse ligaments; all these, with the exception of the ligamentum teres, surround the joint. The ligamentum teres, however, is united to an ovoid depression in the head of the femur, and very powerfully assists in preventing its dislocation. At its lower extremity the femur articu-

lates by means of its condyles with the patella and the tibia.

The leg consists of two long bones; these are the tibia and the fibula. The patella in front of the knee may be regarded as a sesamoid bone. Taking them in topographical order from above downwards, the patella (*c*, Plate III.) first presents itself to notice. It is a flat bone of an irregular triangular shape, and forms what, in common parlance, is called the knee-cap. It serves to protect the joint from external injury, and to increase the power of the muscles extended over it by making them act at a greater angle. It articulates with the two condyles of the femur, and gives attachment at its lower extremity or apex to the ligamentum patellæ.

The tibia (*d*, Plate III.) is, next to the femur, the longest and strongest bone in the skeleton, and occupies the internal and anterior part of the leg; it is expanded at both extremities for powerful articulation with the femur above and the fibula and astragalus below. The superior expansion (or the inner and outer tuberosities) presents on its upper surface two large concavities for articulation with the condyles of the femur. This articulation is strictly a ginglymoid or hinge joint, and is powerfully held in position by the ligamentum patellæ, the transverse, lateral, and other ligaments.

These ligaments play a very important part in genu valgum and genu extrorsum, to which I shall have occasion to refer more fully hereafter.

The inferior expansion of the tibia is much smaller, and supports the articulation with the fibula externally and the astragalus below. The large projection on the inner side of the bone forms the inner malleolus, or ankle bone. The inferior surface of the bone for articulation with the astragalus is smooth and almost flat.

The fibula (*e*, Plate III.) is a slender bone, placed on the outside of the leg, and the smallest of all the long bones in proportion to its length. It articulates by means of an arthrodial or gliding joint, permitting very little motion, with the tibia, at a point a little below the articulation of the latter with the femur, and is therefore excluded from the formation of the knee-joint. The shaft forms an irregular cylinder, and expands at its lower extremity to form the outer malleolus. By means of this tuberosity it articulates with the tibia on its inner side and with the astragalus inferiorly. It is united to the tibia by strong ligaments at the points of articulation, and by a ligament existing between the bones throughout their entire length, called the interosseous ligament.

The osteology of the foot is much more com-

plicated than that of the leg. Its description may be conveniently divided into three parts: that of the tarsus, the metatarsus, and the phalanges.

The tarsus consists of seven bones—the astragalus, the os calcis (or calcaneum), the cuboid, the scaphoid, and the outer, middle, and inner cuneiform bones.

The astragalus (Plate III., *f*) is the medium of articulation between the leg and the foot. It possesses a large rounded head, and a broad smooth facet for articulation with the tibia and fibula. It rests upon the os calcis beneath, and articulates with the scaphoid in front.

The ankle is a hinge joint, admitting of flexion and extension, combined with slight rotation. The tendo Achillis supplies the place of the slighter ligaments posteriorly, whilst anteriorly and laterally ligaments are strong and abundant.

The os calcis (Plate III., *g*) is the largest bone of the tarsus, and forms the heel. It is of an irregular cuboidal form, and supplies the bed to which the astragalus transmits the weight of the body. Owing to its position, below and behind the leg bones, it could not be clearly shown in the drawing.

The cuboid bone (Plate III., *k*) is a pyramidal-shaped bone placed on the outer side of the foot, between the calcaneum and the three smaller toes.

It is the last bone on the outer side of the tarsus, and articulates with the os calcis, the scaphoid, and the fourth and fifth metatarsal bones.

The scaphoid or navicular bone, so called from a fancied resemblance to a boat, is situated on the inner side of the foot, between the astragalus and the three cuneiform bones. It articulates with the astragalus, cuboid, and cuneiform bones.

The three cuneiform bones (Plate III., *h*) somewhat resemble a wedge in shape, and are ranged side by side on the inner part of the foot, having the metatarsal bones in front, the scaphoid behind, and the cuboid externally, with all which bones they articulate.

All the tarsal articulations are arthrodial or gliding joints, except that between the astragalus and the tibia and fibula, very slight motion being permitted between any of them.

The metatarsus (Plate III., *l*) consists of five long bones, of which the first, belonging to the great toe, is extremely large and strong comparatively with the rest. They are exactly similar in structure to the long bones of the leg.

Considerably more motion is permitted between the tarsal and metatarsal bones than between the tarsal bones themselves. A very large protuberance or tuberosity is visible on the outer side of

the posterior extremity or base of the fifth metatarsal bone.

The phalanges (Plate III., *m*, *n*, *o*) differ in no way from the metatarsal bones. They are fourteen in number: two for the great toe and three for each of the others. The first row (*m*) articulates by means of hinge joints with the metatarsal bones and the second row; the second row (*n*) with the first and third; and the third (*o*) with the second.

PLATE IV

Fig 1

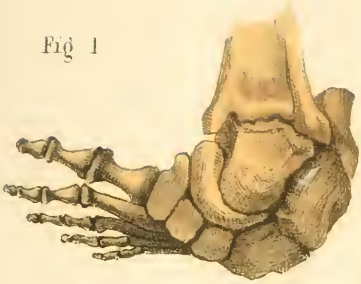


Fig 2

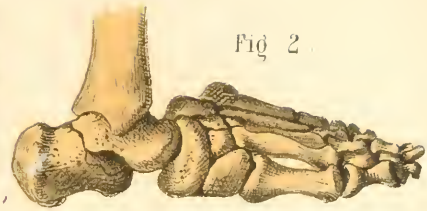


Fig 5

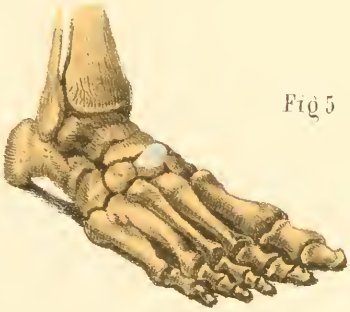
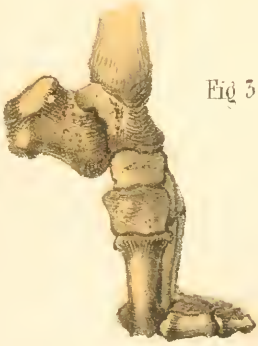


Fig 4

Fig 3



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CHAPTER IV.

Review of last Chapter—The Muscles—Their Functions—Mode of Action—Appearance and Composition—Mode of describing a Muscle—Tendons—Fasciæ—Division of Muscles of Lower Extremities—The Iliac Region—Anterior Femoral Region—Tensor Vaginæ Femoris — Sartorius — Quadriceps Extensor — Internal Femoral Region—Gluteal Region—Posterior Femoral Region—Biceps—Semitendinosus—Semimembranosus—Muscles of the Leg —Anterior Region—Tibialis Anticus—Extensor Proprius Pollicis —Extensor Longus Digitorum—Peroneus Tertius—Posterior Region—Gastrocnemius—Soleus—Posterior Region, Deep Layer—Popliteus—Flexor Longus Pollicis—Flexor Longus Digitorum—Tibialis Posticus—Fibular Region—Peroneus Longus—Peroneus Brevis—Muscles of the Foot—Dorsal Surface—Extensor Brevis Digitorum—Plantar Surface—First Layer—Abductor Pollicis—Flexor Brevis Digitorum—Abductor Minimi Digiti—Second Layer —Third Layer—Transversus Pedis—Fourth Layer.

Having examined the general structure of the osseous portions of the human body, and described somewhat in detail those portions of it with which our subject is more intimately connected, and seen what are the relative positions which these portions occupy with respect to each other, and the method in which they are united together for the purposes of locomotion and the general economy of the body, it remains to show how these several parts are put in action, and how that action, when produced, is governed and controlled.

The muscles are the organs employed to produce every kind of motion in all the joints of the human body. This they do by virtue of their contractile power, which is capable of being either set in action or controlled by the will. Each muscle has its opponent or antagonist in some other muscle; so that when the action of one muscle (or rather its contraction) is excited, the contractility of its opponent remaining in quiescence, the result is an approximation of the parts, usually bones, to which the contracted muscle is attached, and thus movement is produced.

Muscles consist of bundles of reddish contractile fibre; these bundles, being made up of many smaller ones, may again be resolved into primitive fasciculi, which are small tubes made up of a number of minute filaments, called primitive fibrils; these consist of a number of small nucleated cells united to each other in rows; the fasciculi and fibrils give to the various parts of a muscle a longitudinally striated appearance. Muscles contain many nerves and blood-vessels.

In describing a muscle, the term "origin" indicates its more fixed and, for the most part, central attachment, and the term "insertion" the moveable point upon which its action is directed.

The white shining cords called tendons form the terminations of muscles, more especially at

their points of insertion; they are possessed of considerable strength, but no contractility, and but very little elasticity.

The fasciæ are not greatly implicated in deformity, but as mention will be made of them occasionally it may be observed that they consist of fibro-areolar tissue, and invest the softer parts of the body in two layers: the outer serving to facilitate the movements of the skin on the subjacent parts and to retain the warmth of the body; the inner to form sheaths for the muscles, and to protect them and the joints from injury.

It will be impossible (as indeed it would be unnecessary) within the limits of this work, to describe fully any muscles but those implicated in the production of deformity. I shall therefore only glance at them in the normal condition, merely describing their action, but dwelling more carefully on those muscles involved in the deformities hereafter to be treated of.

The muscles of the lower extremities are divided into those of the iliac region, the thigh, the hip, the leg, and the foot.

Those of the iliac region are three: the psoas magnus, the psoas parvus, and the iliacus; these all serve to flex the femur upon the pelvis or the pelvis upon the femur, and to rotate the thigh outwards.

The muscles of the thigh are subdivided into those of the anterior femoral region, the internal femoral region, and the posterior femoral region; those of the anterior femoral region are the tensor vaginæ femoris, the sartorius, rectus, vastus externus, vastus internus, cruræus and subcruræus. The whole of the muscles of the thigh are surrounded by the deep layer of fascia which is here unusually strong, and so extensive as to be called the fascia lata.

The tensor vaginæ femoris is a small muscle extending from the ilium to a few inches down the external surface of the femur; it is inserted into the strong fascia lata, and by keeping this tense facilitates the action of the muscles of the thigh generally.

The sartorius, the longest muscle in the body, is flat, narrow, and riband-like; it arises from the anterior portion of the crest of the ilium, passes obliquely across the front of the thigh, and terminates in an aponeurosis or tendon, which curves slightly forward, and is inserted into the upper and inner surface of the tibia.

The rectus femoris, vastus externus, vastus internus, and cruræus are all included under the general name of the quadriceps extensor.

The rectus femoris, arising by two tendons, one from the ilium and one from above the acetabulum,

proceeds straight down the leg, and terminates at the patella, forming part of the common tendon of the quadriceps extensor.

The vastus externus makes up the largest part of the quadriceps extensor; it arises from the great trochanter and for some distance along the femur below this prominence, and terminates at the upper and outer edge of the patella, furnishing the largest portion of the common tendon of insertion.

The vastus internus and cruræus, which are inseparably united, correspond with the last muscle, but lie at the inner side of the femur, all four of the muscles forming the quadriceps extensor uniting to form one strong tendon, attached to the patella, which is really a sesamoid bone developed in it, the ligamentum patellæ being the proper tendon of the quadriceps extensor, carried down below the patella, and inserted into the tubercle of the tibia.

The subcruræus is a small muscle which prevents the synovial membrane from getting between the joint surfaces, and thus protects it from injury.

The quadriceps extensor, as its name imports, extends the leg upon the thigh; the sartorius flexes the thigh upon the pelvis, and the leg upon the thigh; it also adducts the thigh; the tensor vaginæ femoris acts only upon the fascia lata in the manner already described.

The muscles of the internal femoral region are

the gracilis, pectineus, and adductores longus, brevis, et magnus; of these, the gracilis, which extends from the pubis to the inner tuberosity of the tibia, assists the sartorius in flexing the leg upon the thigh; it also assists the other muscles of this region which are powerful adductors of the thigh.

The muscles of the gluteal region affect the movements of the hip joint chiefly, and need not be particularly described.

The muscles of the posterior femoral region, or back of the thigh, are the biceps, semitendinosus, and semimembranosus.

The biceps arises by two heads: the longer from the tuberosity of the ischium, the shorter from the linea aspera; these unite a little above the knee joint, and the resulting tendon is inserted into the head of the fibula, and by a few fibres, into the outer tuberosity of the tibia.

The semitendinosus, so called from the great length of its tendon, arises from the tuberosity of the ischium, passes downwards and inwards, and terminates in a tendon which curves round the inner tuberosity of the tibia, and is inserted into the upper part of the inner surface of its shaft.

The semimembranosus is also situated at the inner and back part of the thigh; it arises from the outer part of the tuberosity of the ischium, and is inserted into the posterior part of the inner tube-

rosity of the tibia. The biceps, semimembranosus, and semitendinosus, together with the gracilis and sartorius, form, by their tendons, the inner and outer hamstrings; their action is to flex the leg upon the thigh, and by their oblique direction to rotate it outwards by means of the biceps, and inwards by the semitendinosus and semimembranosus; acting from below, that is to say, taking the leg as their fixed point or origin, they draw the body backwards, as in feats of strength, &c.

The fascia of the leg invests the whole of this part except the inner portion of the tibia. The muscles of the leg may be conveniently divided into four regions—the anterior tibio-fibular region, the posterior tibio-fibular region, the posterior region, deep layer, and the fibular region. All these muscles play a very important part in the pathology of pedal distortion, and require careful and attentive study.

The muscles of the anterior tibio-fibular region are the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius.

The tibialis anticus is situated on the outer side of the tibia, and takes its origin from the outer tuberosity of that bone and from the upper and outer portion of its shaft; it then crosses to the front of the leg, passes under the annular ligament, and is inserted into the inner cuneiform bone, and

the base of the metatarsal bone of the great toe; its action is to flex the tarsus upon the leg, and to raise the inner margin of the foot.

The extensor proprius pollicis arises from the anterior surface of the shaft of the fibula for about its middle three-fifths; it lies between the tibialis anticus and the extensor longus digitorum. From its origin it passes downwards, through the annular ligament, and terminates in a tendon which is inserted into the base of the last phalanx of the great toe; its action is to extend the great toe, and to assist in flexing the tarsus on the leg and in raising the inner margin of the foot.

The extensor longus digitorum arises from the outer tuberosity of the tibia, from the shaft of the fibula, and from the deep fascia of the leg; it passes downwards and slightly forwards and inwards, and terminates in a tendinous expansion, which, after passing through the annular ligament, divides into three tendons, one of which again subdivides, forming four altogether, one of which is inserted into the base of the last phalanx of each of the four lesser toes, of which it is a direct extensor.

The peroneus tertius arises from the lower fourth of the front of the shaft of the fibula, passes downwards through the annular ligament, and is inserted into the base of the metatarsal bone of the

little toe; it is a flexor of the ankle, and also an elevator of the outer margin of the foot.

Thus all the muscles on the front of the leg are either extensors of the toes, flexors of the tarsus, or elevators of either the external or internal margin of the foot. While some both extend the toes and flex the ankle, others again may either flex the ankle or elevate the margin of the foot, but do not act on the toes.

The posterior muscular region consists of two layers, of which the outer or superficial contains the gastrocnemius, soleus, and plantaris muscles.

The gastrocnemius arises by two heads or tendons, one from each condyle of the femur; these unite, and form a muscular expansion, which passes directly downwards, and joining the soleus, forms the tendo Achillis, the thickest and strongest tendon in the body; it is about six inches in length, and is inserted into the lower part of the posterior surface of the os calcis.

The soleus is a large, powerful, flat muscle, lying immediately beneath tho gastrocnemius; it originates from the heads and upper part of the shafts of the tibia and fibula, passes directly downwards, joins the gastrocnemius, and forms part of the tendo Achillis.

The plantaris is a small and unimportant muscle, lying between the two large calf muscles.

These muscles are employed to raise the heel from the ground in almost every kind of locomotion; hence they are constantly being called into action and strengthened by exercise. They serve also to steady the leg upon the foot when the body is in the erect posture. The gastrocnemius will also flex the thigh upon the leg.

The deep seated muscles at the back of the leg are the popliteus, flexor longus pollicis, flexor longus digitorum, and tibialis posticus.

The popliteus is a flat, triangular muscle, lying immediately beneath a special fascia derived from the insertion of the semimembranosus. It arises from the external condyle of the femur, crosses the back of the leg obliquely downwards, and is inserted into the posterior part of the upper third of the shaft of the tibia. This muscle assists in flexing the leg, and, when bent, in rotating it inwards.

The flexor longus pollicis, which, with the two following muscles, lies under the deep fascia which intervenes between the two muscular layers, arises from the lower and inner part of the shaft of the fibula, passes behind the astragalus, under the os calcis, and into the sole of the foot, and is inserted into the base of the last phalanx of the great toe, of which it is a direct flexor, and an opponent to the extensor longus pollicis. If its action be continued it will extend the tarsus upon the leg.

The flexor longus digitorum arises from a large portion of the posterior surface of the shaft of the tibia, passes behind the inner malleolus and beneath the os calcis, and then divides into four tendons, one of which is inserted into the base of the last phalanx of each of the four lesser toes. The action of this muscle is to directly flex the toes. Notwithstanding that it passes from the inner side of the foot, it flexes the toes in a line parallel with the long axis of the foot by means of an accessory muscle, which draws its tendon into the middle line of the sole.

The tibialis posticus lies between the two last named muscles, arising from the shafts of the tibia and fibula, crossing under the tendon of the flexor longus digitorum, passing behind the inner malleolus, and being inserted into the scaphoid and inner cuneiform bones. Its action is, in some degree, the reverse of that of the tibialis anticus, as it extends the tarsus and turns the sole of the foot inwards; the latter muscle flexing the ankle as well as turning the sole inwards.

The muscles of the fibular region are the peroneus longus and the peroneus brevis.

The peroneus longus arises from the upper two-thirds of the outer surface of the shaft of the fibula, and after winding behind the outer malleolus and outside the os calcis, crosses the sole of the foot,

and is inserted into the base of the metatarsal bone of the great toe and the inner cuneiform bone. Its action is to extend the foot upon the leg, and to turn it outwards. It is an antagonist of the tibiales muscles, especially of the posterior.

The peroneus brevis pursues for some distance the same course as the peroneus longus, but instead of crossing the foot, continues on its outer edge, and is inserted into the metatarsal bone of the little toe. Its action is to extend the foot and slightly to evert and abduct it.

The tendons of all the leg muscles, except the popliteus, are firmly bound down to the ankle by strong bands of tissue, called annular ligaments.

The muscles of the foot are divided into those occupying its upper or dorsal, and those of its lower or plantar surface.

The plantar fascia forms, in the centre of the sole, a thick fibrous structure, but diminishes in bulk towards the sides. From its under surface septa are given off to encase the muscles underneath.

The only muscle on the dorsal surface of the foot is the extensor brevis digitorum. This arises from the upper surface of the os calcis, and divides into four tendons, which assist the tendons of the extensor longus digitorum to form an expansion on the dorsum of the first phalanx, which again sends

prolongations forward to the terminal phalanges. These tendons go to the four inner toes, but the tendon to the great toe differs from the others in having a separate special insertion. This muscle assists the extensor longus digitorum in extending the toes.

The plantar muscles consist of four layers, of which the first or outer contains the abductor pollicis, flexor brevis digitorum, and abductor minimi digiti.

The abductor pollicis arises from the inner tuberosity of the os calcis, and certain adjacent fibrous structures, and running along the inner border of the foot is inserted into the base of the first phalanx of the great toe, of which, as its name implies, it is an abductor.

The flexor brevis digitorum is a fac-simile of the extensor brevis digitorum, to which it is an antagonist, and occupies the same position on the sole of the foot as its analogue does on the dorsum.

The abductor minimi digiti arises from the outer tuberosity of the os calcis, runs along the outer border of the foot, and is inserted into the first phalanx of the little toe, which it abducts.

The second layer of plantar muscles contains the tendons of the long flexors as well as the accessorius and the lumbricales, which are assistants of the long flexors of the toes.

The muscles of the third plantar layer are the flexor brevis pollicis, flexor brevis minimi digiti, and transversus pedis.

The transversus pedis assists in drawing the toes together. The action of the other muscles of this layer is entirely confined to the great and little toes, and is sufficiently indicated by their names.

The interossei, which constitute the fourth layer, are situated between the metatarsal bones. They are all abductors from or adductors to the median line of the second toe. The tendon of the peroneus longus and the insertion of the tibialis posticus are also in the fourth layer.

We have now completed our survey of the anatomy of the parts concerned in deformities of the lower extremities, in their normal condition. In the second part it will be shown how the paralysis of some of the muscles described, or the morbidly excited action of others, produces distortion and renders curative aid necessary.

CHAPTER V.

Object of the Chapter—Screws and Levers not used as Active Agents for applying Force, but only as Means of Adjustment—The Mechanical Powers enumerated—Definition of a Lever—Its Application—The Fulcrum—Three Classes of Levers—Examples of each in the Human Body—The Inclined Plane—The Screw—Its Action—Ratchet Joints—Their Construction and Action—Modes of combining Ratchets so as to produce Movement in any required Direction—Application of the Screw to produce Movement in opposite Directions—Application of Ratchets to Talipes Varus—Demonstration of Correctness of Principle upon which a Typical Instrument for Varus is constructed.

Previous to commencing the description of the mechanical apparatus employed in the treatment of deformity, it is necessary, for its better comprehension, to give a brief outline of the theory and application of the leading principles of applied mechanics, so far as they refer to the instruments hereafter to be described, especial reference being made to the manner in which the screw is employed in the construction of ratchet joints, arrangements of very general and important use in mechanical therapeutics, chiefly on account of the facilities they afford for delicate and accurate adjustment. It must always be carefully borne in mind that the screw, the lever, &c., are never used as power-

ful means of applying force in any required direction, but merely of altering the relative position of the several parts of any apparatus as the cure progresses, any requisite pressure being exercised by soft bandages surrounding the limb at various parts of its surface. This necessary explanation being offered, I proceed at once to the discussion of the mechanical forces.

All mechanical contrivances are capable of being referred to one or more of the modes of applying force known as "the mechanical powers." These are usually cited as six, viz., the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw. Since, however, the screw and wedge may be regarded as modifications of the inclined plane, and the wheel and axle as a modification of the lever, the mechanical powers are ultimately reduced to three: the lever, the pulley, and the inclined plane.

A lever is generally defined as a rigid rod, capable of turning upon a point in its length; this point being termed the fulcrum. The object of a lever, and, in fact, of any of the mechanical powers, is either to transfer a force from one point to another, at the same time causing it to act with greater, equal, or less intensity, as may be desired, or else to cause a particular movement given at one end of the machine to be transferred to the other end,

the movement being variously modified when transferred. In mechanics, the force which it is desired to transfer is called the power; the resistance to be overcome by the transferred force is called the weight; while the hinge, pivot, or point upon which the machine turns is called the fulcrum. Thus, in using a pair of scissors, the force exerted by the thumb and finger at the bows is the power; the cohesive force of the material cut is the weight or resistance to be overcome; while the rivet upon which the arms of the scissors turn is the fulcrum.

Levers are divided into three classes, according to the relative positions of the power, weight, and fulcrum. Thus, if the power be at one end of the lever, the weight at the other, and the fulcrum between them, we have a lever of the first order; if the power be at one end, the fulcrum at the other, and the weight between them, we have a lever of the second order; while if the weight be at one end, the fulcrum at the other, and the power between them, we have a lever of the third order. The reader will no doubt call to mind the many examples of these varieties of levers. I may, however, give two or three illustrations selected from the many that are met with in the human body. And here it may be remarked that the levers in the animal economy mostly act at

what is sometimes, though incorrectly, called a disadvantage — that is, the power, by moving through a short distance, effects a considerable movement of the weight.

As an instance of a lever of the first order, may be quoted the forearm in the act of extension. Thus the triceps muscle, acting upon the ulna, is the power, the elbow joint is the fulcrum, while the forearm itself is the weight. In raising one's-self on tiptoe we have an example of the second order of lever. The power is applied by means of the gastrocnemius and soleus muscles acting through the tendo Achillis upon the os calcis; the toes form the fulcrum, while the whole body is the weight. The third kind of lever is illustrated by the forearm in the act of flexion, the weight being the whole weight of the forearm, the elbow-joint the fulcrum, and the biceps muscle, acting through its tendon upon the radius, the power.

The wheel and axle consists simply of a wheel rigidly fixed to an axle, the power acting upon the wheel being transferred to the axle and thus effecting motion in the weight. In orthopædic mechanism we meet with this arrangement in the key, winch, or milled head used for turning the screw of a ratchet-joint.

What is commonly called the pulley is but rarely made use of in orthopædy; but it should

be mentioned that, in lacing, we actually apply the principle of the pulley, the lace being the cord, and the eyelet holes through which the lace passes being moveable pulleys.

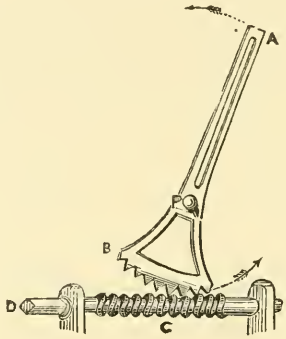
The inclined plane is a hard inclined surface, and is used where it is desired to raise a heavy weight through a short distance. The wedge consists of two hard surfaces inclined to each other, and is employed to separate two yielding surfaces, or to produce pressure upon two surfaces.

The screw is a machine of extensive use in therapeutic mechanism, and hence deserves a particular description. The screw is a cylinder, having a projecting thread of a spiral form on its surface. The cylinder can be turned round by a winch, key, or milled head; a pin, a projecting thread, or one of the teeth of a cog-wheel, fits into the groove formed by the projecting threads of the screw, and consequently, when the screw is turned, the pin, the tooth of the wheel, or whatever may be between the threads of the screw, is moved forward or backward, if the screw be fixed and the point moveable, or the screw itself progresses or retrogresses if it be moveable and the point fixed. It could readily be shown that the force which may be brought to act upon the resistance depends upon the distance between the threads, and also upon the diameter of the screw. The screw is of general application, but

in surgical appliances its use is chiefly to act upon one arm of a lever.

A ratchet-joint is an instance of this application of the screw. The construction of this apparatus will be best understood from Fig. 1. (P) is a point upon which the bent lever (A B) can turn. One arm (B) of the lever is spread out fan-like, and has several teeth cut in its margin. These teeth work in the groove of the screw (C). It will readily be

Fig. 1.

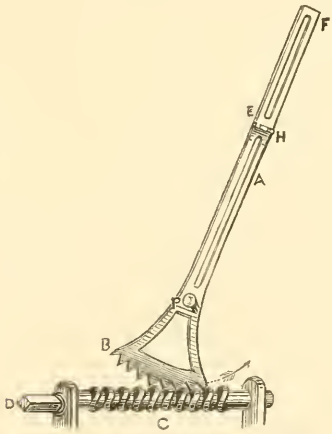


seen that, supposing the screw (C) to be turned by a key fitting on its axle (D), the teeth, and consequently the arm (B), will be moved forward or backward, according to the direction in which the screw is turned, the arm (A) being at the same time moved in an opposite direction, as indicated by the arrows. And here it may be mentioned that, if the screw be turned towards the reader, the wheel will move in the direction of the inclination of the threads,

thus (in Fig. 1) the screw being turned towards the reader—*i.e.*, the top of the screw moving towards him—the wheel will move to the right, seeing that the threads are inclined to the right.

It is essential in rectifying deformities of the limbs to have an arrangement for producing motion of levers in various directions at the same time. This is effected by using two or more of the

Fig. 2.



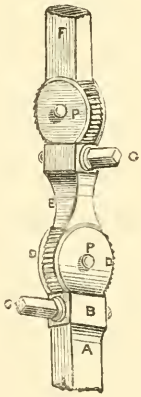
ratchet-joints just described. On looking at Fig. 2 it will be seen at a glance that the extremity (A) of the lever can only move in the plane of this paper—*i.e.*, can only move to the right or to the left. Let a second arm (E F) be jointed (at H) to the arm (A) by means of a hinge, which allows E F to move in a plane perpendicular to the plane

of this paper; it is evident that if the hinge be open the arm (E F) will move just as though it were firmly united to the arm (A)—that is, will move in the plane of this paper, either to the right or to the left. If now it be required to move (E F) in a plane at right angles to the plane of the paper — *i.e.*, in the woodcut — to move towards or from the reader, it is merely necessary to move (E F) at the joint (H). If it is necessary to make (E F) move either towards or from the reader at the same time that it is moving to the right or left, it is necessary to move (E F) on its hinge at the same time that it is being moved by the ratchet-joint. If another arm were hinged obliquely at the extremity (F) of (E F), the extremity of this additional arm could be made to move in three directions. Thus, if the hinge (H) were rigid, and also the hinge at (F), the extremity would move to the right or left. If the hinge (H) be turned, then the extremity would move forward or backward; while if the hinge (at F) were turned, it would move obliquely, and if both hinges were turned at the same time the extremity would evidently be moved to the right or left, forward or backward, and obliquely, all these motions being effected at the same time.

If this explanation has been understood, the reader will readily comprehend the arrangement of

levers and ratchet-joints used to effect combined motion. Fig. 3 shows an arrangement for producing two motions; the stem (A) is secured firmly to some fixed part of the apparatus; near the extremity of (A) is a box (B), containing a screw which can be turned by a key fitting on the triangular pin (C). (D and D′) are two ears, between which is placed the wheel-like extremity of the lever (E), which turns on the pin (P) whenever the screw (C) allows it

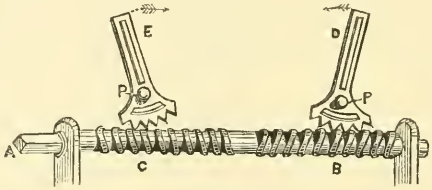
Fig. 3.



to move; the lever (E) terminates in a box and ears precisely similar to those of (A), but being placed at right angles to these; (F) is a lever terminating in a wheel and turning on a pin (P′); the teeth of the wheel work in the threads of the screw (G); it will easily be seen that by moving the screws (C G) motion may be given to the lever (F) in two directions.

Another application of the screw is for the purpose of producing motion simultaneously of two levers in opposite directions. This is effected by having two screws on different parts of the same axis, the screws (B C) being threaded in opposite directions (*see* Fig. 4). Ratchet-arm levers (D and E) connected with pivots (P P) work in the screws. Since when a screw is turned towards the reader, the ratchet-wheel moves in the direction of the threads, it is evident that in the arrangement represented in

Fig. 4.



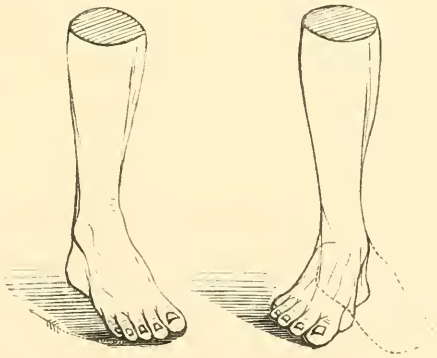
the figure the left wheel will be turned to the left, and the right wheel to the right, the levers moving in opposite directions, as indicated by the arrows. On reversing the motion of the axle upon which the screws are placed the levers will be turned in contrary directions; so that by simply applying a key they may be made to approach to or recede from each other.

Seeing, then, that by means of ratchet-joints we are enabled to effect movement of a lever in any

desired direction, their application to the rectification of deformity is simple. The deformed part must be carefully studied with a view of ascertaining what movement is required to bring the part into its normal position, the centre of distorted motion being especially sought for, as it affords a clue to the proper centre of mechanical motion in the apparatus to be applied for its restoration.

In some cases, as, for example, talipes calcaneus,

Fig. 5.



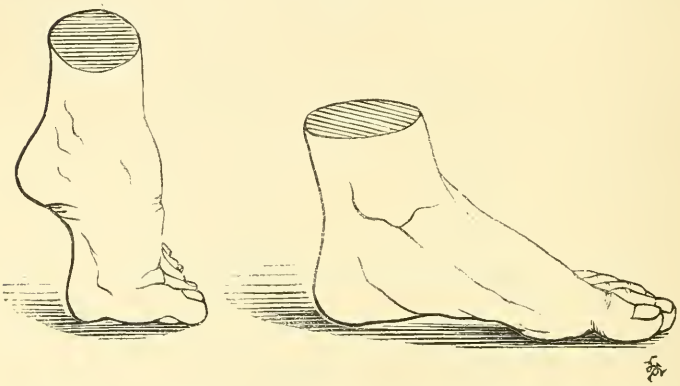
or talipes equinus, movement is only required in one direction; but when the foot departs in several ways from its normal line, then several corresponding movements are required. Take, for example, common talipes varus, or club-foot. The general external appearance of this deformity is represented in Plate I., Fig. 1 (frontispiece). Now, to understand the movements required to correct a deformity

of this description, let us compare the appearance of a normal and a varous foot from three points of view.

First, looking directly at the front of the foot (Fig. 5), it will be seen that the anterior part of the foot requires to be moved in the direction of the arrow—*i.e.*, outwards.

Second, looking from the side, directly at the

Fig. 6.

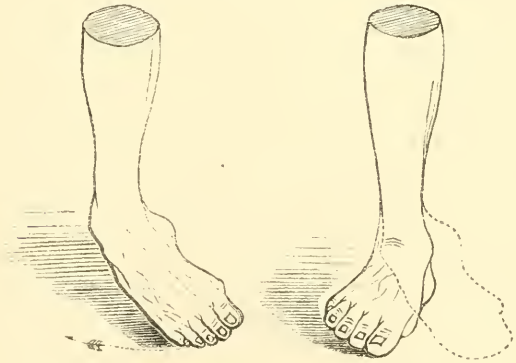


external margin of the foot, it is evident that the heel requires to be lowered.

Lastly, let the normal and deformed foot be compared, supposing them viewed from the front, the observer looking directly at the toes (Fig. 7). The appearance of the normal foot will be the same as in Fig. 5; but the deformed foot will be as in Fig. 7, from which it will be seen that the inner margin of the foot requires to be depressed.

The deformity has thus been analysed into three elements, consisting of movement of the front of the foot inward, of the heel upward, and a partial rotation of the foot; we have now to apply a ratchet-joint which shall act upon the front of the foot so as to turn it outwardly, and a second to produce motion of the heel downwardly, whilst a third produces motion in an opposite direction to that in which the foot is rotated.

Fig. 7.

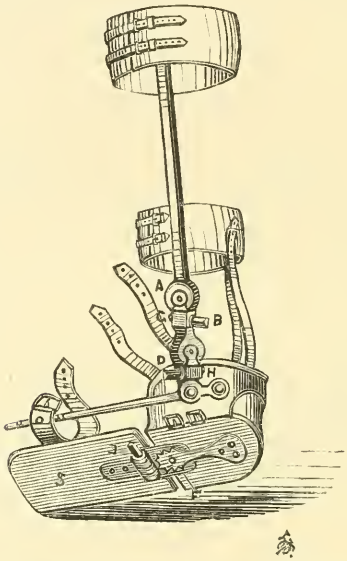


To complete the present chapter, it only remains for me to describe an instrument actually used in the treatment of the deformity which has just been analysed, and to show the various parts of the apparatus by which the desired results are obtained, and that such instruments are constructed on scientific principles.

Fig. 8 represents such an instrument.

It will be recollected that three motions are necessary to restore the foot to its normal position; first, as will be seen by (Fig. 5,) the toes require to be turned outwards; this is effected by moving the key (E), for then the sole (S) is moved on its hinge at (F), and the front part of the

Fig. 8.



foot being strapped to (S), is compelled to move with it.

On referring to Fig. 6, it is seen that the heel is required to be depressed; this is effected by the ratchet-joint (H); on turning the key (D), since the wheel (C) is fixed, the shoe is compelled to move, and it will be seen most easily from the figure that

when the screw (D) is turned to the right, the heel must be depressed.

To completely restore the foot, a third motion is required, namely rotation outwards on its short axis (see Fig. 7). This is accomplished by the ratchet-joint (A B, Fig. 8) on turning the key (B), since the wheel (A) is fixed, the lever (H) is depressed, and being firmly fixed to the heel-piece of the shoe, carries that with it, and thus flattens the sole and completes the restoration.

This instrument is merely selected as a type of its class, the correct action of all others of scientific construction being capable of similar demonstration.

PART II.

CHAPTER I.

Plan of the Second Part of the Work—Talipes Varus—Its Synonymes—Grades of Severity—Causes of First Grade—Appearance and Causes of Second Grade—Third Grade—Aggravation by Neglect—Alteration in Shape of the Bones—Instruments for Simple Varus—Angular Splints—Simple Leg Instrument—Mr. Barwell's Treatment—His Ideas of the Mechanism of the Foot—Salt's Elastic Cord Instrument—Orthopædic Footstool—Instruments for Secondary Varus—Dr. Little's Improvement of Scarpa's Shoe—Instrument with Lateral Ratchet—Instrument with two Rectangular Ratchets—Instrument with Curved Shaft—Instrument for Obstinate Inversion of the Toes—Dr. Little's Instrument for Severe Varus—Laangard's Instrument—Instrument by Adams—Salt's plan of Applying Rubber Tendons—Case of Unusually Severe Varus—History of the Case and Description of the Mechanism employed—Retentive Instruments for Varus—Dr. Little's New Shoe.

The first part of this work having been devoted to introductory topics and to the description of the healthy anatomy of the parts implicated in the deformities now about to be more fully discussed, this, the second part of the book, will contain a detailed description of the external appearance of each class of distortion, the actual internal changes in the relative position of the parts concerned, and the causes which operate in their production; fol-

lowing this will be found a concise and accurate description of all the approved mechanical appliances which are employed, both by myself and other mechanicians for the relief and cure of these distortions, together with an explanation of their application and action. The deformity which first presents itself to notice, by reason of its frequency and comparative severity, is talipes varus, popularly known as club-foot, and styled in the French and German languages respectively, *pied-bot* and *klump-fuss.*

This is the most common form of distortion to which the human foot is liable, and may exist in several grades of severity; in the first stage it is found alone, that is to say, without the coexistence of any other species of deformity; but in its severe forms it is always connected with talipes equinus, or uplifting of the os calcis or heel bone.

The first and mildest form of talipes varus consists of simple inversion of the anterior portion of the foot, and is produced by the preponderating influence of two muscles chiefly, namely the tibialis anticus and the tibialis posticus (Plate V. Fig. 1, *d* and *b*), over their antagonists, viz., the three peronei muscles, longus, brevis, et tertius: thus when children are observed constantly and involuntarily to turn their toes in, it is a sure sign of incipient varus, and unless they are taught constantly

to exercise the opponents of the contracting muscles by the power of the will, deformity must ensue.

The second grade of talipes varus is shown in outline (Plate V.) from an external (Fig. 2) and an internal view (Fig 3): it presents three variations from the normal shape of the foot; the toes are inverted or adducted as in the first grade; the inner margin of the foot is raised by the continued and increasing action of the tibiales anticus et posticus (*d* and *b*), and at the same time the heel is uplifted by the contraction of the gastrocnemius and soleus muscles, acting by the tendo Achillis (*a*), the normal action of which is to extend the foot upon the leg.

The third degree is an exaggeration of the second; in it the contraction of the tibial muscles is so great as to present the sole of the foot inwardly, in a plane almost vertical with the horizon, whilst the dorsum looks outwards; the plantar fascia is greatly contracted, and the scaphoid bone is drawn upwards and inwards (Plate IV. Fig. 1), with persistent flexion of the toes caused by contraction of the flexor longus digitorum, (Plate V. Fig. 1 c., Fig. 4 a.), diminished length of the foot and concavity of its arch; the os calcis is also drawn upwards and inwards by the muscles of the calf.

All these conditions belong to congenital talipes, and are referable to alterations in the muscular

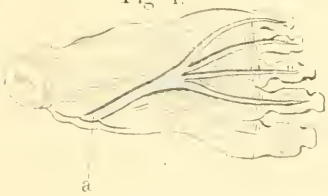
PLATE V

Fig 1

Fig 2

Fig 3.

Fig 4.



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system alone. So soon, however, as the patient begins to walk, other and extraneous forces are brought to bear which rapidly increase the severity of the distortion. Thus, in varus of the second degree, which is the most common form, the patient treads upon the outer and anterior margin of the foot, that is to say, upon the cuboid and fifth metatarsal bone or little toe. The superincumbent weight of the body sometimes displaces this bone, and causes it to rotate on its long axis until it is doubled under the sole of the foot, thus throwing the weight upon the fourth metatarsal bone, which, in its turn, sometimes yields, and is displaced in like manner.

The continued use of the distorted foot not only alters the position of the bones, but sometimes even their shapes, by the mutual attrition of surfaces not naturally intended for contact with each other. The general appearance of the bones of a varous foot is shown (Plate IV. Fig. 1).

The scaphoid bone, in particular, becomes greatly altered in shape, and a facet is formed by means of which it articulates with the inner malleolus; it is sometimes worn almost to transparency by friction with the head of the astragalus; the os calcis is drawn upwards in a curve, and forms an articular facet with the outer malleolus; the cuboid bone is worn into a conical shape, and by its position as the

keystone or wedge of the arch of the foot, opposes much resistance to its restoration. All the bones of the leg and foot become very greatly atrophied.

In very severe cases of congenital distortion, originating at an early period of pregnancy, the shape of some of the tarsal bones is found to be altered, and the leg is frequently rigidly extended by the quadriceps extensor. This is usually accompanied by some derangement of the cerebral or spinal system. Mr. Brodhurst relates several cases of this kind, in which the patellæ were drawn some considerable distance up the thigh, and one in which they were altogether missing.

In cases of talipes of great severity and long standing, the ligaments as well as the muscles of the foot are contracted or extended according to their position, and also lose their elasticity; so that when the deformity has been removed, and the foot restored to its natural shape, considerable difficulty is sometimes experienced in imparting to the articulations sufficient firmness and stability to prevent relapse.

In the most aggravated condition of varus, almost every muscle in the leg and foot is implicated, being either contracted or extended. Those muscles which suffer contraction are the extensors, invertors, and adductors of the tarsus, and the flexors of the phalanges—namely, the gastrocnemius, soleus,

tibiales anticus et posticus, flexor longus digitorum, adductor pollicis, transversus pedis, flexor brevis minimi digiti, and flexores longus et brevis pollicis.

The opponents of these muscles are in a state of constant extension; they are the peronei, longus, brevis, et tertius, extensores longus et brevis digitorum, and abductor minimi digiti.

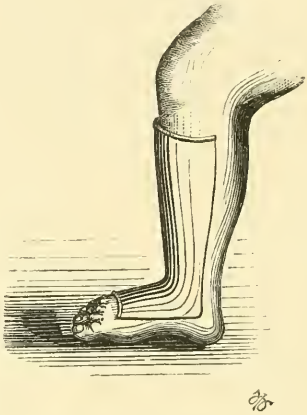
These, then, are the external appearances and internal changes which take place in the formation of the various stages of talipes varus; and from a consideration of them, we shall be able to deduce the principles upon which an instrument should be constructed, in order that it may scientifically perform the part required of it by supporting and assisting the weaker and more debilitated muscles, so as to enable them to recover their due tone and contractility, and to again equalize the balance of power between the antagonistic muscles.

In simple varus but one deviation from the true and normal line of the foot is observable. This, as I have before remarked, consists of inversion of the anterior portion of the foot, and is chiefly caused by contraction of the tibialis anticus; any force, therefore, which acts in a direction opposite to that of this muscle, will have the effect of replacing the foot. This is a very simple form of distortion, and readily admits of cure.

The first and simplest appliance (Fig. 9) which is

adopted for the cure of this stage of varus is usually applied after the performance of tenotomy has rendered the reduction of the foot to its proper shape easy of accomplishment. It consists of a padded iron splint, diverging at the tarsal articulation at a right angle, and slightly hollowed to fit the leg, against the front of which it rests, the padding preventing abrasion. To this splint, first the leg

Fig. 9.

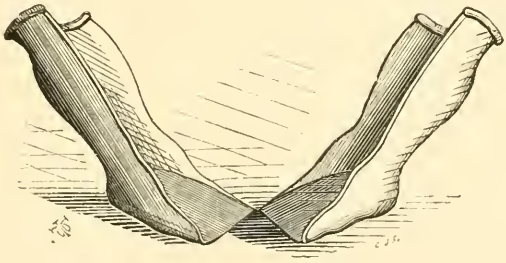


and then the foot is securely bound by soft rollers, and so retained in its proper position. This form of splint is only applicable to the treatment of slight cases of congenital varus in very young children after the performance of tenotomy.

Sometimes this splint is applied on the posterior part of the leg and the sole of the foot, in which case the concavity is reversed (as Fig. 10). Fre-

quently a series of such splints is used, set at different angles, and changed as the position of the foot improves. Dr. Little informs me that he has recently modified these splints by hingeing them at the heel; so that by méans of a screw any angle may be obtained, and the inconvenience and expense attending the employment of a set for each case is avoided.

Fig. 10.

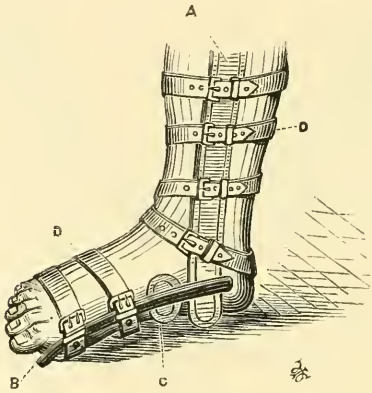


Another elementary contrivance consists (Fig. 11) of a slightly-hollowed wooden splint (A), extending from the heel to a little below the knee on the outer side of the leg. To this lateral stem is attached, at a point a little below the tibio-tarsal articulation, a steel lever or spring (B) which lies along the external margin of the foot. Upon this lever slides a suitable pad of oval shape (C), which is intended to rest against the cuboid bone. The apparatus is represented in the drawing (Fig. 11) as applied to a valgous instead of a varous foot, the splint, spring, and pad being consequently

placed inside instead of outside the leg. The application of the instrument is evident. The lateral upright stem is firmly strapped to the leg by bands (D), and the toes are drawn to the lever (B) by means of a soft webbing band (D′), counter-resistance to which is set up by the cuboidal pad.

When the arch of the foot is contracted a wooden or steel sole is added to this form of splint, for the

Fig. 11.



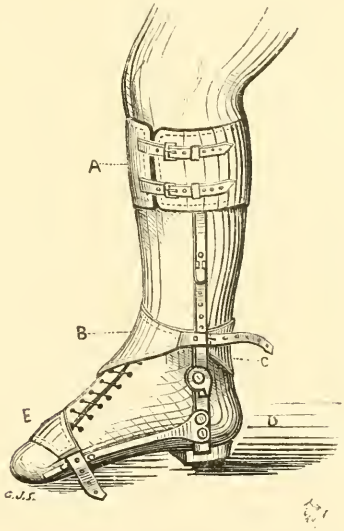
purpose of elongating or extending the arch; this is effected by strapping the foot to the sole with gently increasing force, by means of a webbing band passing over the uplifted bones, thus making the heel and toes fulcra, by the aid of which the necessary force may be applied.

Improvement in this instrument being carried still further, the lateral upright is made of steel, and furnished with a padded calf band, and a lateral

joint coincident with the tarsal articulation, thus preventing all risk of the supervention of ankylosis from rigid confinement of the limb in one position for a length of time.

Whenever the sole is used I add a heel-piece and laced toe-cap, which assist in retaining the foot within the grasp of the instrument, and form a slipper, which protects it from the effects of cold.

Fig. 12.



Another appliance suitable for older patients, and such as can walk, is shown (Fig. 12). It consists of two steel shafts (only one of which is seen in the drawing, by reason of its being a side view), which ascend the leg, one on either side, as high as a little below the knee-joint, where they are both united to

a padded metal band (A), which surrounds the calf and retains the shafts in their position. The lower extremities of these shafts (D) are riveted between the soles of an ordinary boot, laced rather nearer the toes than usual, with such an amount of obliquity as will evert the foot sufficiently. A lateral joint is placed opposite the natural ankle-joint on each shaft, having a stop which prevents extension of the foot beyond a right angle, and consequent uplifting of the heel. A strap (B), shaped similarly to the letter V, invests the outer ankle-bone, and is reflected round the inner shaft (at C), and buckled there with moderate tightness; so as to support the external malleolus.

Should the oblique set of the "stirrup" in this instrument be insufficient in itself to correct the adduction of the toes, a steel spring (D) is added, similar to the one attached to the last-described instrument, acted upon by a strap (E) fixed on the inner margin of the boot, at a point opposite to the base of the first metatarsal bone.

When the inversion of the foot is very great, a strong tendency is observed to rotate the shafts and calf-band on the leg. When this is the case, the evil must be obviated by prolonging the outer leg stem to two or three inches above the hip, lateral joints being, of course, supplied opposite to the natural ones of the hip and knee, and a padded

metal band made to receive the thigh, and another the pelvis, the elliptical form of which latter prevents any possibility of rotation of the apparatus.

Any one of these instruments will suffice to effect a cure of incipient varus, if accurately fitted in the first instance, and carefully watched from time to time; but to those who aim at the advancement of science, it is not sufficient merely to effect a desired object, although this may be accomplished by clumsy apparatus; they further seek to render the means employed as scientific as possible, and perfectly appropriate to every required condition of the part or parts to be acted upon.

Following up this idea it always appeared to me that something was wanting to perfect these instruments; and from a careful consideration of the anatomy of the parts, I came to the conclusion that the fault was in treating the foot as if it were a solid whole, instead of being, as it really is, a whole made up of a great number of parts.

Whilst considering this subject I read Mr. Barwell's ingenious volume on the treatment of club-foot, in which, while contending against the practice of tenotomy, he advocates the treatment of distortion by mechanical means alone, applied in a manner peculiar to himself. His method involves considerable trouble, great nicety of adjustment, and more of the surgeon's personal care and attention than

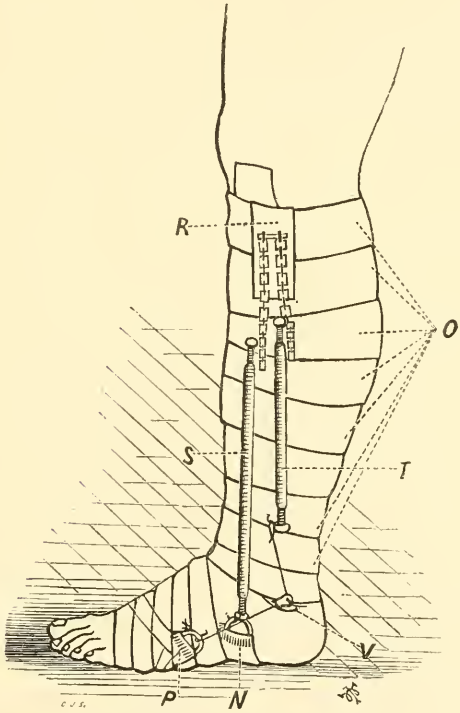
can, in the generality of cases, be conveniently given. Nevertheless, as the plan is novel, and one from which I have drawn some useful ideas in connexion with the construction of the apparatus usually employed by myself in the treatment of cases of simple varus, I take the liberty of extracting a short explanation of his method of procedure, and also two woodcuts taken from his work for its more perfect illustration.

Mr. Barwell considers that any inequality of power existing between two opposing sets of muscles should be remedied, if possible, not by destroying, for a time at least, the power and action of the stronger ones, but by assisting the weaker ones to regain their proper strength and functions. This he endeavours to effect by supplementing the action of the enfeebled muscles by the tension of cords of elastic rubber applied to the foot, and made to exert their force in a direction as nearly as possible the same as the muscles and tendons they are designed to assist. The insertions of muscles he imitates by means of adhesive plaster retaining a hook, to which the rubber cord is looped, whilst on the leg. At their origin he fixes a piece of tin, slightly hollowed and curved to the shape of the leg, and firmly held in its place by plaster. From a hook on this plate he obtains a fixed point of resistance, by the

aid of which the spring acts on the foot. The two woodcuts (Figs. 13, 14) and their explanations, which are copied verbatim from Mr. Barwell's book, will show this more clearly:—

"(N) The upper part, with a wire loop, of a

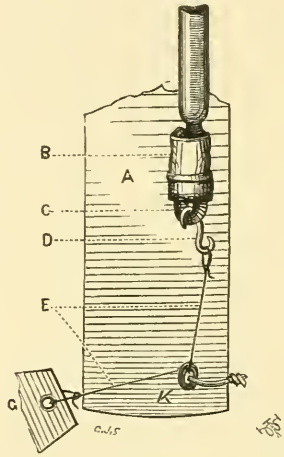
Fig. 13.



trapezoid piece of plaster, the continuation of which, under the circular pieces, is marked by lines, and which adheres over a rather broader surface of the sole than the insertion of the peroneus longus.

(P) The end with its wire loop of a piece of plaster representing the insertion of the peroneus brevis; its continuation is marked as being split, so as to embrace the base of the metatarsal bone. (O) Circular strapping covering but one piece of tin placed just behind the fibula, with its layer of plaster on either side. (R) The remainder of the longitudinal strip of plaster brought down and adherent to the

Fig. 14.



circular one (O). (S) An india-rubber spring assisting the peroneus longus. (T) An india-rubber spring assisting the peroneus brevis. At the lower part of it is seen an arrangement for changing the direction of the force. The end of the spring is covered with tubing to guard the hooks.

"Fig. 14 represents the lower end of a piece of tin, upon which, by means of a twisted wire, a barren eyelet has been fastened. Through this eyelet a piece of catgut runs from the piece of strapping to the hook in the loop of the india-rubber spring. Upon this loop is a short piece of tubing, the lower end of which is turned up, displaying the hook, &c. When this part is turned down it completes the arrangement by covering the hook and preventing any possibility of slipping."

The principal fault, as I have before stated, of nearly all mechanical shoes for the cure of club-foot, whether it be varus or valgus, is, that they treat the foot as a solid mass, instead of as an articulated system.

Another defect in these instruments is, that they assume the centre of distorted motion to exist in the tibio-tarsal articulation, instead of, as it really does, at a point between the astragalus posteriorly, and the cuboid and scaphoid bones anteriorly. Mr. Barwell offers some remarks which are so very pertinent and apposite to this subject, that I cannot forbear quoting them.

He says:—"The foot, constructed as an instrument combining great strength with mobility, consists of twelve bones (besides those of the toes), all of which are united together by means of regularly-constructed joints. The whole mechanism is articu-

lated with the leg by the talus or astragalus, which is received into the two leg bones at the ankle-joint, as a tenon is fixed into a mortise. This articulation permits only of flexion and extension—that is, of pointing or turning up the toes; no other movement whatever, whilst the bones of the leg remain motionless, can take place in this joint. The action called turning the toes out or in is produced by the rotation of the thigh and leg on the hip-joint when the knee is straight; but when the knee is bent that movement is effected by a revolving motion of the fibula, acted upon by the tensor vagina femoris and biceps muscles of the thigh, the anterior slip of the external lateral ligament being especially adapted to communicate this movement to the astragalus.

"All other actions of the foot, such as turning the sole inwards or outwards, heightening or lowering the arch, &c., take place in the joints amongst the eleven other bones of the limb. To each of these eleven bones one or more muscles are attached, having the office, not only of producing movement, but also of keeping these parts in that position and relationship to each other which constitutes the economy and beauty of the exquisitely-constructed support.

"Of all the joints in the front of the foot, the chief agent in its flexibility and security is one that runs

across its whole breadth, just in front of that part which supports the weight. It lies between the astragalus and os calcis behind, and the scaphoid and cuboid in front, and is very well named the medio-tarsal joint. It allows of flexion and extension, adduction and abduction; also rotation inwards and outwards on the long axis of the foot. . . .

"And I must here point out that with the exception of the tendo Achillis, and part of another cord, every tendon passing from the leg to the foot is inserted in front of the medio-tarsal joint. Thus every muscular contraction (except that of the sural muscles, producing raising of the heel and slight inward rotation of the foot) acts primarily on the anterior half of the foot and medio-tarsal articulation, and only secondarily on the back part and on the ankle-joint. . . . .

"All mechanical shoes are formed essentially of an unyielding sole, to which the child's foot is fastened, and then twisted round as a whole, as nearly as possible on the ankle-joint, which really has no rotatory movement, and therefore nothing to do with the malpostures of rotation. . .

"Let the reader consider our description of the medio-tarsal joint; of the manner in which the front part of children's feet can be turned round upon that articulation till the forepart of the sole looks inwards, and can be adducted and flexed to a

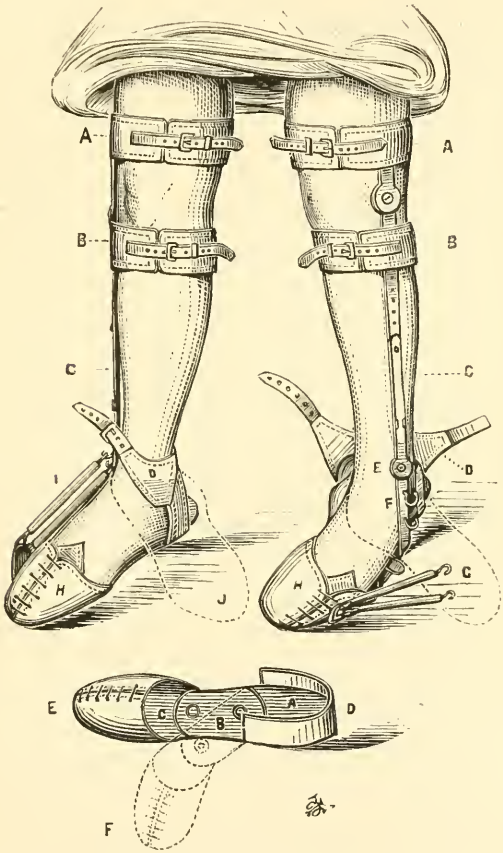
marvellous degree. Let him also remember that every muscle, except the tendo Achillis and a portion of another, is inserted in front of that joint, which must therefore yield to all muscular action, and that to such action club-foot is due. Let him also examine a club-foot—a varus, for instance—and he will very soon be convinced that the real deformity lies in the front of the foot, and that the change in position at the ankle-joint is secondary, and really very slight. In fact, he will see that the front part of the foot is rotated and adducted on the back portion; and that, therefore, to overcome such deformity, the force must be applied to the anterior portion of the limb."

A careful consideration of the statements thus advanced by Mr. Barwell led me to consider how those objections, which must be acknowledged to be valid, might be obviated. The instrument I devised with this view is shown (Fig. 15), and described as follows :—

Similarly to the ordinary instruments a steel shaft (c) is carried up the leg to a point about three inches above the knee on its outer side, being freely jointed at the knee and ankle, and made to slide so as to admit of its length being increased or diminished; it is attached to the leg by a carefully-padded band (A B), above and below the knee joint.

Thus far it differs in no way from the instruments of ordinary make; the sole, or clog, however (D E), is entirely different from that of any other

FIG. 15.



apparatus; it consists of three pieces (A B C), each rotating on the other, and thus offering no resistance to the manipulation of the foot anteriorly to

the astragalus. They are connected each to each by loose rivets; the sole has a heel piece (D), and a laced toe-cap (E). To the leg stem (which is attached to the sole by a loose rivet), at a point between the malleolus externus and the sole, are attached two india-rubber cords (I or G), of equal thickness, (one quarter-inch diameter), but of unequal length; the shorter of these is hooked on to the middle part of the sole, and the longer to the front or toe-piece; immediately this apparatus is adjusted, the anterior portion of the foot is rotated outwards (as shown by the dotted lines) to an extent commensurate with the tension at which the cords are applied; this is effected without in any degree interfering with the natural movements of the foot or ankle-joint, as the rubber tendons do not rigidly restrain the foot, thus abrogating the necessity for exercising the feeble and degenerate muscles, but rather assist them in their efforts to restore the balance of muscular power, and incite them to regain their normal strength and vigour.

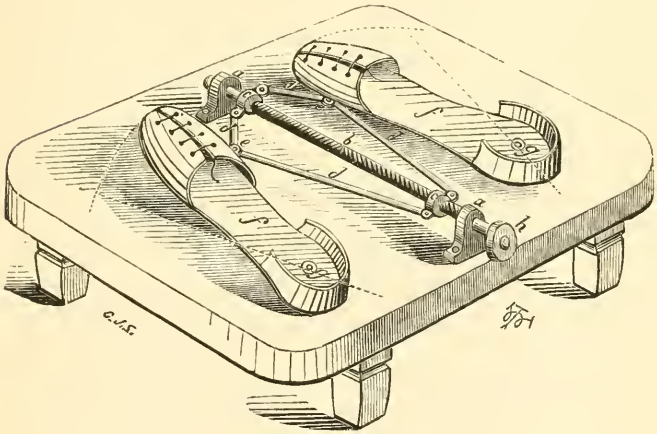
This apparatus I have found to answer my most sanguine expectations in the treatment of simple varus; in the more advanced stages of the deformity, it is not so applicable for many reasons.

It is a matter of frequent occurrence that children, varying from the age of six to ten, are brought to me on account of having contracted the habit of

constantly turning in the toes (especially when sitting at school), this being usually accompanied by inversion of the feet, there is also slight sinking of the outer malleolus of each foot; yet the condition is not such as to warrant resort to steel supports, although, if not corrected, absolute deformity may ensue.

It occurred to me that a footstool might be ad-

Fig. 16.



vantageously designed for occasional use which would do all that was necessary; the woodcut (Fig. 16) represents my contrivance, and may be described as under.

Upon a low footstool of ordinary dimensions are mounted two standards (*a a*), which serve to carry a right- and left-handed screw (*b*), upon which

screw are two threaded bosses (*c c*), and to these are attached, by means of pivot centres, arms (*d d*), these arms being again jointed (at *e*) to a small piece of metal fixed into either a shoe or a slipper (*f*), the heels of which are held down to the stool, but freely rotate on centres (*g*); it will be obvious that by the action of turning the set-piece (*h*) or knob of the screw, the bosses (*c*) will move gradually towards each other on the screw, and towards the centre, by reason of the screw being right and left handed, and by this motion the arms (*d*) assume a more acute angle, forcing by degrees the anterior parts of the slippers outwards, until they assume the required position as indicated by the dotted lines.

It will seen by reference to the diagram that the feet are slipped within toe-caps, and the heels rest against raised heel-pieces; a few turns of the thumbscrew will give the necessary eversion.

For the use of schools it is expected that the "Orthopædic footstool," as I have named this apparatus, will be found very valuable, it being applicable either to inversion or eversion of the feet by simply reversing the action of the thumb-screw.

A less expensive form of this apparatus is made by removing the mechanical arrangement of screw, bosses, arms, &c., and substituting a rubber tendon attached to the outer side of each toe-cap, whilst the other end is fastened to the centre of the adjacent

PLATE VI

side of the footstool, the contraction of the rubber cords serving to evert the feet; I prefer the first described arrangement as being more under the control of the attendant.

From simple varus in its first stage we turn to the second grade of the deformity, in which it exists as equino-varus, being always accompanied by uplifting of the heel; Plate VI., being a lithophotograph from a case which occurred in my own practice, very well illustrates this deformity.

In this grade, it will be observed, three variations from the natural shape of the foot are noticeable, namely, adduction of the toes, raising or inversion of the inner margin of the foot, and uplifting of the heel; hence it will appear that movements corresponding with these are required in the instruments calculated efficiently to treat this distortion, instead of one only, as in simple varus; much more complication is requisite in their mechanism, greater nicety of workmanship, more care in their adaptation and application, and watchfulness in their progress. The second and third degrees of varus, which follow in order, are, perhaps, even more complicated and difficult of treatment than any other distortion, on account of the several alterations which take place in the position, and sometimes even in the shape, of the tarsal bones.

As might have been expected, the complication

of the malady directed the thoughts of surgeons and mechanicians very early and frequently to its relief; and numerous mechanical appliances, more or less efficient, have been the result of their labours; so numerous are they, indeed, that I shall only be able to figure and describe such as in my own opinion, and in that of others qualified to judge, are considered really efficacious and are generally adopted.

Chief among all these appliances stands the celebrated invention of Scarpa, which, through many of its modifications and improvements, still bears his name and points to its origin.

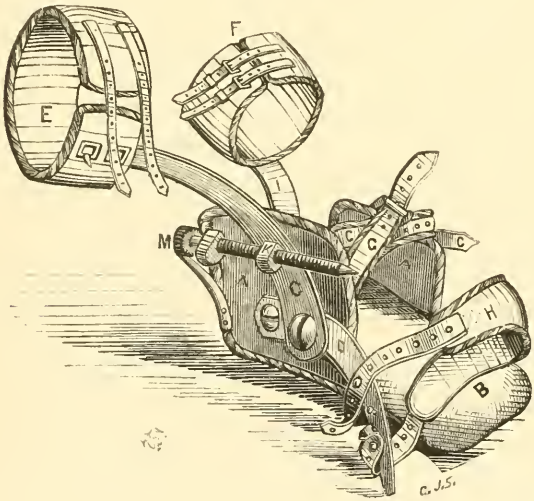
Scarpa is said to have borrowed the idea whence his invention sprang from a French charlatan named Tiphaisne, who in the eighteenth century attained considerable success in the mechanical treatment of club-foot, by appliances no doubt sufficiently clumsy and unskilful, but still constructed on principles somewhat approaching correct ones.

Scarpa's first productions were probably crude in the extreme, and I shall consequently commence by describing his instrument as improved and modified by Stromeyer and subsequently by Dr. Little, from whose excellent work on deformity I have copied the two diagrams, and whose own explanation I give verbatim. The first woodcut (Fig. 17)

represents the shoe in the position it naturally assumes before the application of the straps; the second (Fig. 18) as it is applied to the foot, showing the action of each part.

"The letters (A, B) in the diagram (Fig. 17) designate a shoe formed of iron, covered with leather and well padded with horsehair; (C) is a steel spring,

Fig. 17.



which, by means of the padded strap (E), is worn upon the outside of the leg; (I and F) show a strap and bandage to go round the ankle, by which the heel is held securely in the shoe; whilst the short spring (D) draws the toes and front of the foot outwards by means of the padded strap (H). The

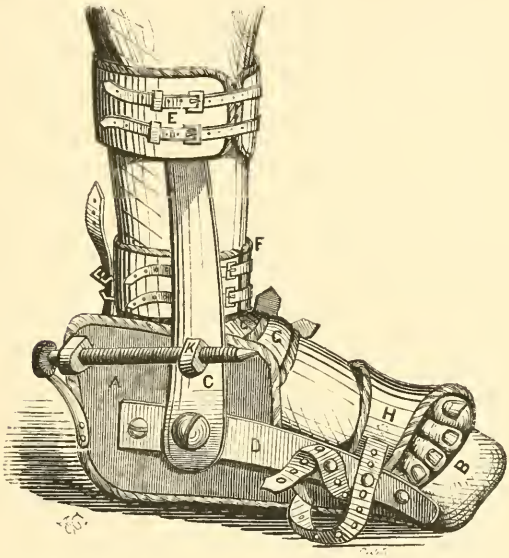
screw which moves through the female screw (K) (itself fixed as a rotary rivet to the spring C) acts upon the ankle joint, and enables the surgeon to bend it as rapidly or as gradually as he may please. The active and passive causes of adduction and rotation inwards of the foot, analogous to supination of the hand, are overcome by the springs, which, being braced up against the foot, more or less loosely according to the exigencies of the case, tend constantly to regain the form which they have when unshackled with the straps, and thus gradually overcome the contracted muscles or ligaments, as the case may be, and draw the deformed foot in two directions opposite the deformity, those of abduction and rotation outwards."

"Since," as Dr. Little further observes, "success in the employment of any particular instrument is as much the result of the manner of application as of its peculiar efficiency," I shall also, with the engraving of the shoe in action (Fig. 18), quote the improver's directions for applying it properly to a deformed limb:—

"The ankle band (F) detached from the band (I) should be buckled round the leg above the malleoli. Holding the shoe part of the instrument in the left hand, the heel should be placed with the right in the shoe, and secured by means of the strap (G G)

firmly against the inside (A, Fig. 17); the heel should be prevented from rising by fastening the strap (I) to the back part of the ankle band (F) and the spring (C), by means of the circular band (E), formed of thin metal and properly padded, be applied to the outer side of the leg; this will effect

Fig. 18.



a change in the ankle-joint similar to that ensuing to the wrist when the hand is pronated. The inner margin of the foot being then directed to the ground, in opposition to the natural tendency of talipes varus, the toes should be drawn as far outwardly as can be effected without pain by means of the padded strap (H), attached to the spring (D).

Lastly, the ankle should be bent by turning the screw (L) with a key constructed for the purpose, as far as the tense tendo Achillis will permit; as the screw (L) acts through the female screw (K), which is fixed as a rotary rivet upon the spring (C), and (T) is merely a stud through which the smooth part of the screw existing between the termination of the thread and the knob (S) can move freely forward and backward, a certain degree of motion is allowed in the ankle-joint in the act of walking, tending to increase its flexion, whilst the position of the screw (L) prevents the heel from becoming elevated. If the spring (C) act, in directing the inner margin of the foot to the ground, too powerfully and painfully, a piece of tape or a small strap may be attached to the inside of the band (E) which is applied around the leg below the knee, and fastened to a buckle on the inside of the foot; this will moderate the action of the spring, which can be increased in the daytime and diminished during the hours appropriated to rest."

The ascent of the heel may conveniently and effectually be prevented by attaching two straps to the ankle-band, one on either side; and by taking them through holes in the sole of the instrument; more direct command is thus obtained over the heel than by the method shown in the diagrams.

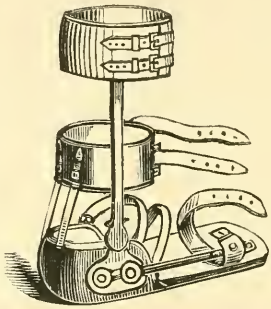
I have thought it well to quote so long an explanation of the construction and application of this instrument, both because I have found it, when well made, to be a very good and useful apparatus, and because it was the type from which most of the other shoes of this kind now in use were constructed. Moreover, I wish fully to impress upon the minds of my readers the urgent necessity for careful application of every orthopædic instrument; let an apparatus be made with the greatest possible care and accuracy, one mistake in the application and securing of the straps may completely defeat the plans of the mechanician; hence it is that the mechanician should, under no circumstances whatever, undertake the treatment of a case unless an opportunity is afforded him of personally examining the patient, and applying the apparatus when first constructed. My own experience is that every case ends in failure more or less in which this is not strictly enjoined and practised.

Another shoe of similar construction (Fig. 19, page 104) is made of a metal sole and heel-piece, from the outer side of which latter rises a vertical shaft to a point midway between the ankle and the knee, where it is surmounted by a padded metal band encircling the leg; this shaft is supplied with a lateral ratchet-joint opposite the tarsal articulation. A spring lies along the external margin of

the foot, which is drawn towards it by means of a soft toe-strap; straps are added, which cross the instep and retain the heel in the place destined for its reception, and the instrument is completed by a band tightly encircling the ankle, and united to the heel-piece by two vertical straps.

This instrument is applied in a manner almost exactly similar to the one last described; the heel is secured in the shoe, and the leg to the shaft, the ankle-

Fig. 19.

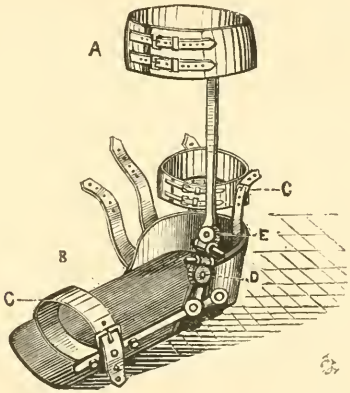


band adjusted and the anterior portion of the foot abducted by means of the toe-strap, which should be fastened tightly as convenient; the ratchet at the ankle is then to be slowly turned so as to depress the heel until very slight tension upon the tendo Achillis is observed; gradually the pressure is increased until the equinous tendency is overcome, and the heel can be placed flat upon the ground.

This apparatus produces two corrective move-

ments, namely: first, abduction of the anterior part of the foot; and secondly, depression of the heel and expansion of the plantar arch. It is very serviceable where the obliquity of the sole is not considerable; when this is the case, although the action of the toe-spring tends to relieve it, on account of the vertical shaft running straight up the leg, and thus forming a rigid lever or point of

Fig. 20.



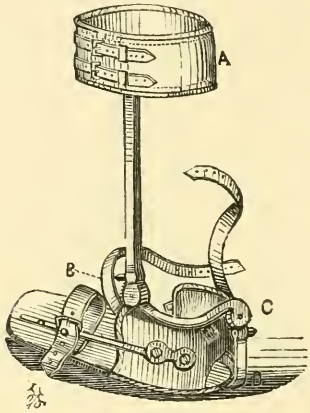
resistance, instead of diverging from it and acting as a spring, as in Dr. Little's shoe, we are obliged to seek for other and more powerful means to effect the desired object.

For this purpose an instrument (Fig. 20) is employed, consisting, similarly to the last, of a metal sole (B), a vertical shaft and calf-band (A), ankle-band (C), and toe-strap and spring (G). Thus far it differs in no way from (Fig. 19), but in

addition to the ratchet (D) used in the latter instrument to depress the heel, a second is placed immediately above it (E), acting at right angles to it. The action of this, of course, is to rotate the foot on its short axis, and flatten the sole at the same time that the other parts of the apparatus evert the toes, extend the plantar arch, and depress the heel.

An instrument (Fig. 21) which combines all

FIG. 21.



three of the movements requisite to correct talipes varus, is constructed as follows: as in the other instruments, a metal sole and heel-piece receive the foot which is securely retained therein by straps, and the usual ankle-band; from the centre of the back of the heel springs a steel shaft bearing a ratchet centre opposite to the ankle-joint, acting transversely to the long axis of the foot; the shaft,

immediately above this tangential screw, curves round the heel with a slight downward dip to the outer malleolus, where a lateral rachet is fixed; it then proceeds upwards in the ordinary manner, and is surmounted by a calf-band; the instrument also carries a longitudinal spring, and a strap for everting the toes.

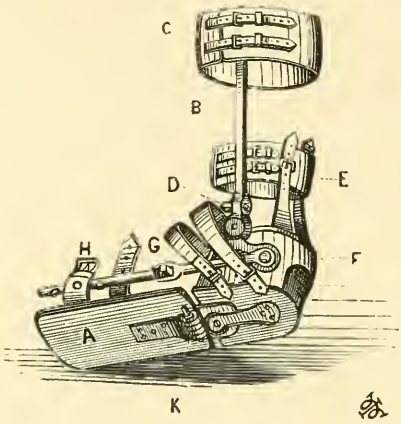
By means of the curves taken by the shaft between the first and second ratchet centres, this instrument exerts a very peculiar mechanical action, the toes being everted at the same time that the foot is flattened; this is a very useful form of apparatus, but is somewhat liable to get out of order unless great care is taken in its use.

In cases of very obstinate inversion of the anterior portion of the foot, or when the pressure exercised by the spring produces abrasion of the cuticle, the instrument shown (Fig. 22, page 108) is employed, similar in principle to that drawn (Fig. 20, page 105); the sole, however, is divided across, below the medio-tarsal articulation, and a transverse ratchet (K) is placed at the point of division; the toe-spring also has a ratchet (G). Each of these centres being coincident with the medio-tarsal articulation, the instrument, when carefully adjusted and applied, suffices to restore the worst cases of abduction.

Dr. Little has devised a very useful form of shoe

for the treatment of the most severe forms of varus, the idea of which was taken from the modification of Scarpa's shoe, extracted from his book and shown (Figs. 17 and 18, pages 99 and 101). I append a woodcut (Fig. 23, page 109) of this instrument, a glance at which will show that the chief improvement visible on Stromeyer's shoe (as modified by Little) consists in some alteration of the

Fig. 22.

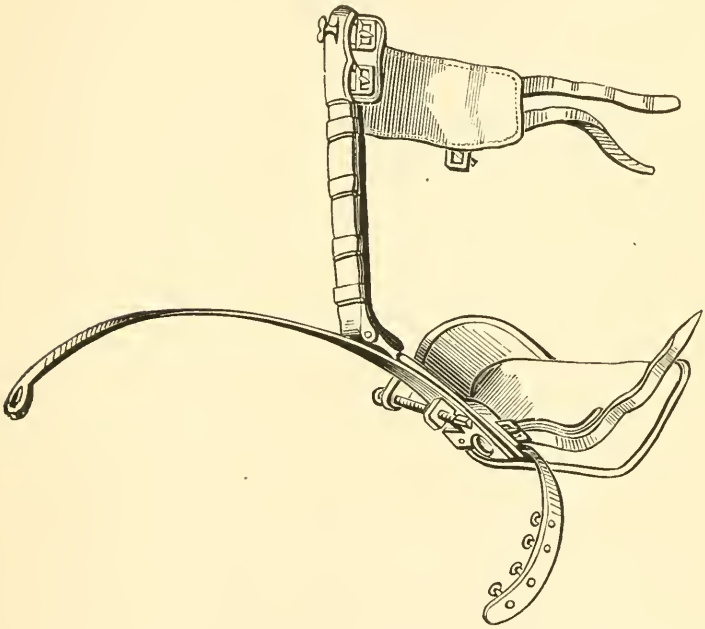


shape and set of the spring, which in the latter is closely bound to the leg, but in the present instrument diverges from it at a considerable angle, and the addition of a lateral lever having two hinges at the ankle, to enable it to accommodate itself to the changed position of the tarsal bones (*see* Plate IV., Fig. 1), and firmly strapped to the leg; to this lever the spring is

secured with more or less of tightness, according to the force required to be exerted. This instrument is extremely useful for conquering obstinate obliquity of the sole and adduction of the toes.

A very efficient instrument has been invented by

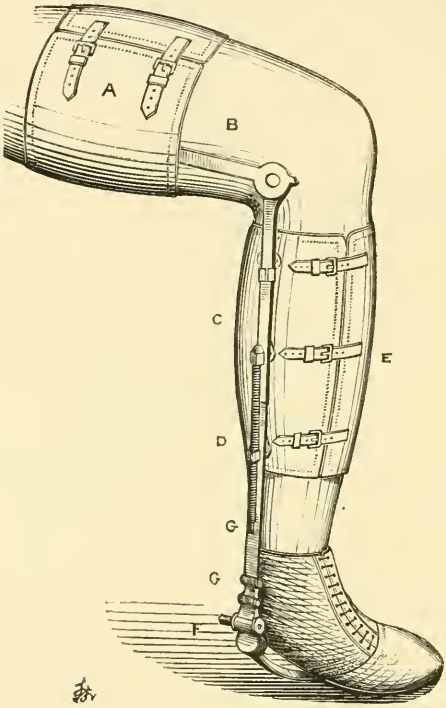
Fig. 23.



Dr. Langaard, of Hamburgh (Fig. 24, page 110); it consists of a strong boot, between the soles of which, on the outer side, or rather between "the welt" (or first sole) and the heel, a steel shaft is riveted. This shaft bears a ratchet of longitudinal action (F), a little above the deformed situation of the heel, or

a little below the natural position of the ankle-joint, and two or more hinges (G) below it. (By inadvertency these hinges are shown above instead of below in the drawing). The shaft proceeds up

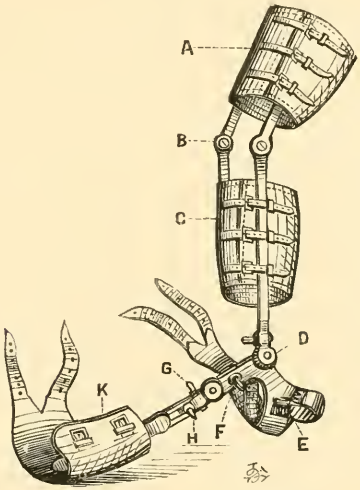
FIG. 24.



the leg (CB), is jointed at the knee, and bears padded thigh and calf bands (AE). It is divided between the knee and ankle, and at the division a perpendicular screw (D) or a rack and pinion movement is so arranged, as to permit of the outer margin of the

foot being raised by diminishing the length of the shaft below the knee, this action serving at the same time to adduct the toes, the hinges allowing the leg stem to follow the altered position of the foot. The obliquity and adduction of the foot having been thus removed, the heel is brought down by the action of the ankle-screw, which, by

Fig. 25.



the altered form of the ankle, will now be opposite the joint it is intended to act upon.

A very ingenious and useful instrument has been invented by Mr. Adams, and constructed originally by Mr. Bigg, from whose valuable and practical Manual I extract a woodcut of the apparatus (Fig. 25), and the spirit of its explanation. This instrument, which is intended for severe

adult varus, divides the treatment into two distinct stages, one for the varus, and one for the equinus. A metal trough (A) receives the thigh, and a second (C) the calf, steel bars jointed (at B) connecting the two. From the outer side of the calf-band (C) descends a steel bar, terminating at the ankle (D) in a lever containing four ratchet centres (D, F, G, H), three for the varus, and one for the equinus. Straps (E) are arranged to retain the heel in its place, and a socket (K) is placed near the extremity of the lever to receive and retain the toes.

The first ratchet (F) is placed opposite the cuboid bone, and unfolds the foot in a downward direction, thus aiding to replace the uplifted scaphoid. The second ratchet (G) acts at right angles to the first, and raises the front of the foot, at the same time turning it outwards; the third (H) is perpendicular to the second, and depresses the inner margin of the metatarsus; whilst the fourth (D) is used in the ordinary manner to extend the tendo Achillis and bring down the heel; this instrument is powerful, yet delicate in its action, and admits of being nicely regulated; it is, therefore, very useful.

Thus much concerning the instruments in general use for the treatment of varus, one or other of which will be applicable to any case that may occur to the medical practitioner in the exercise of

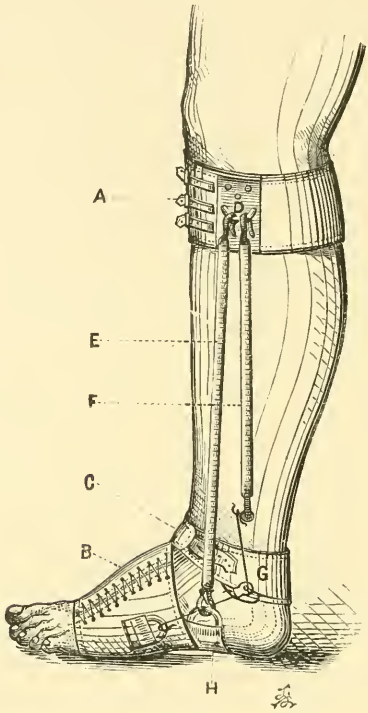
his profession. I will now say a few words respecting a plan I have lately tried and found to answer extremely well.

In my remarks on the treatment of the first stage of varus, I quoted Mr. Barwell's method of procedure by means of elastic cords, stating, also, that from the amount of time and trouble involved in the process I did not think it likely to come into general use; the suggestion however is of value, and I am of opinion that if a simple and easy method of attaching the tendons could be devised, "the rubber system" would occasionally be found very useful, in slight cases, especially for night wear; I have, therefore, endeavoured to provide such a method of attachment. (Fig. 26, p. 114.)

The kind of instrument used with rubber tendons in simple varus (Fig. 15) is inapplicable to the compound varieties of the distortion, on account of the numerous movements required at or near the ankle-joint, in addition to flexion and extension, the only two permitted in that apparatus; I therefore tried the experiment the application of which is seen (Fig. 26, p. 114). A soft band (A) encircles the upper part of the calf, and carries a small oblong piece of metal (D) near the front of the external side of the leg, simulating the origin of the peronei muscles. To this plate is attached a strong loop to permit the attachment of the upper ends of two

rubber tendons (E and F), which proceed down the leg; the longer (E) is attached to a band (H), which passes under the instep after having been secured round the ankle (at G). The shorter (F) takes direction rather more backward, and is hooked a

FIG. 26.



little above the ankle to a piece of catgut which passes through an eyelet in the band (G), and then hooks on to a loop in a soft band (B) encircling the metatarsus.

It will be evident that the action of the first

spring (E) is to flatten the foot, whilst the second (F) everts the toes and extends the plantar arch. This contrivance I have found to answer admirably in some rather severe cases, in which, however, the heel was not greatly raised, it being very difficult to cause the tendons to exercise traction on the os calcis in a downward direction.

Before passing on to the description of the apparatus employed to retain the foot in its proper position, after its restoration during the time necessary for the ligaments to regain their proper tone and elasticity, I could wish to draw attention to three litho-photographs (Plates VII., VIII., IX.) illustrative of varus.

The first (Plate VII.) is a case of varus of the second degree, and is introduced on account of the very clear manner in which it depicts the shape assumed by a varus foot.

The second (Plate VIII.) represents an extraordinarily severe case of congenital varus of the third degree; and the third (Plate IX.) is a view of one of the same feet in an advanced stage of the treatment. As this was a case of unusual difficulty, a history of its treatment may not be uninteresting.

This patient, when brought to me, was a boy of about seven years of age, and, as the position of the feet (Plate VIII.) will clearly show, had never

walked; he could, however, manage to stand by holding on to a table, and when in this posture the entire weight of the body was thrown on the outer malleoli, on which, in consequence of the pressure thus exercised, a callosity was developed. The case seemed utterly hopeless; but I was induced by the parents to attempt its treatment.

As the rigidity of the tibiales and calf muscles was so great as not to permit of any restoration of the feet by the hand, the feet were submitted daily, for a month, to a hot bran bath. At the end of this period they yielded slightly to manipulation, and mechanical treatment was commenced.

The instrument applied consisted of a steel shaft running up the inside of the leg to a little below the knee, then carried round the back of the calf and prolonged to two inches above the hip, joints being supplied opposite the hip, knee, and ankle, and a horizontal hinge below the inner malleolus; bands surrounded the pelvis, thigh, and calf, and the shaft was attached inferiorly to a boot of very peculiar construction.

This boot was shaped to the double curves of the foot, and jointed at the middle or bridge of the sole, the two parts being connected by a piece of india-rubber of about the thickness of a penny, so made that no resistance should be offered by the rigidity

PLATE VIII

Fig 1

Fig 2

of the sole to the mechanism employed to act upon the distortion.

The abnormal changes of shape visible in the feet being three in number, I decided first to attempt the cure of the adduction of the toes and the obliquity of the sole, leaving the extension of the tendo Achillis until a subsequent date.

The two first desiderata I obtained by means of two screws, a longitudinal and a vertical one; the first passed through a threaded socket below the internal malleolus, and acted at a slight angle against a projection in the sole in front of its transverse joint, thus causing all the bones in front of the astragalus to be rotated outwards. The second, or vertical screw travelled through a similar threaded boss above the ankle-joint, projecting about a quarter of an inch to obtain leverage, and to clear the other screw; it acted against a projection in the shaft below the longitudinal hinge, which, I have before stated, was placed under the ankle-joint; this screw rotated the foot on its short axis and flattened the sole. By turning these screws a revolution or two a week, the feet were reduced in a few weeks to a condition of simple talipes equinus.

The sole then forming an inclined plane with very little lateral deviation, attention was directed to the contracted state of the tendo Achillis; a second stem was added, outside the leg, which joined

the first at its bend round the calf; a padded metal band surrounded the back of the ankle, just above the malleoli, and to it, vertically to the centre of the heel, was attached a threaded boss, through which travelled a fine screw, pressing against a projection in the heel of the boot. Application of this screw, with a turn or two weekly, as the pressure could be conveniently borne, quickly restored the foot to the shape shown (Plate IX). It may be added that a simple form of varus boot was used for night wear, and elastic socks after the discontinuance of instrumental support. It will be seen from the description of the instrument as above, that from the screws not being fixed to their points of resistance, but merely pressing against it, no natural movement of the foot was in any way impeded.

The cure has not only been perfect but permanent; the letters (Nos. 2 and 3), received from the boy's father, will be read with interest, inasmuch as the last was written several years after all instrumental treatment had been discontinued without the slightest relapse having taken place; the case is quoted as encouragement, showing, as it does, that even such as seem apparently hopeless, by proper treatment and constant watchfulness, may be successfully combated. I have no doubt whatever that tenotomy in this and in similar cases

PLATE IX.

would greatly shorten the time necessary for treatment, but the friends of the boy would not consent to an operation, so that no alternative was left but the thoughtful and careful application of mechanism to accomplish the end desired.

We now turn to another and a very important part of the subject, namely, the retention of the foot in its new and improved position after the restorative treatment has been completed; this is necessary on account of the inclination to relapse, caused by weakness in the ligaments, generally observable after the curative treatment has been successfully employed.

The first evil which has to be guarded against is a return of the obliquity of the sole and consequent sinking of the outer ankle; an elastic sock surrounding the ankle is sometimes sufficient to remedy this, but should it prove incapable of affording the requisite support, a light steel shaft is inserted into a boot (Fig. 12), and carried half way up the inside of the leg, where it is surmounted by a padded band; it is jointed at the ankle in such a manner as not to admit of extension of the foot beyond a right angle, in order to prevent recontraction of the tendo Achillis; a strap shaped like the letter V is fastened on the outer side of the boot, and buckled round the shaft, thus completely investing and supporting the outer malleolus.

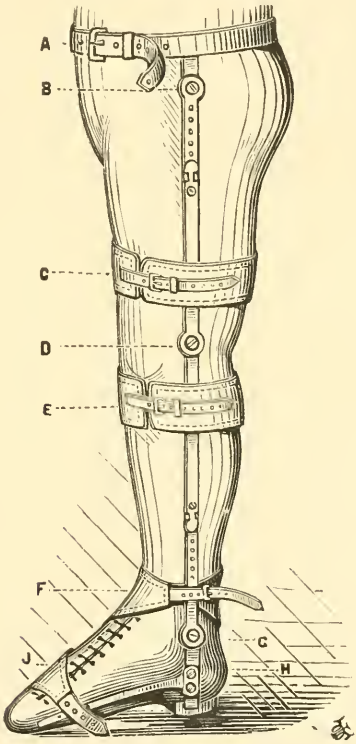
Should this not prove sufficient check to the rotatory efforts of the foot, a shaft is carried up each side of the leg, the other conditions of the instrument remaining the same. The bottom piece or stirrup is secured to the boot with a certain amount of obliquity, for the purpose of everting the foot; sometimes a toe spring is added to assist in effecting this object.

Occasionally these instruments are carried as high as the middle of the thigh, having joints opposite the knee; a little more command is thus obtained over the foot, but it is not of much practical value, as whenever any decided inclination to rotation of the foot is present, it is necessary to carry the shaft as high as the pelvis A, (Fig. 27), jointing it at the hip (B), the knee (D), and the ankle (G), bands (A C E) surrounding the pelvis, thigh, and calf; the oval configuration of the pelvis then prevents all possible chance of rotation. The diagram shows the V-strap (F) as applied to valgus, for varus a second shaft is carried up the inside of the leg as high as the calf-band, the strap supporting the outer instead of the inner malleolus.

An instrument which is very successful, on account of its great lightness and consequent inaptitude to fatigue its wearer, is shown (Fig. 28 p. 122). In it a steel bar, attached to a boot (D) in the usual manner, and jointed at the ankle, ascends

the inside of the leg as high as the upper part of the calf, where it is joined by a transverse piece (C), which, after crossing the back of the leg, curves upwards, is jointed at the knee and hip, and bears a padded thigh- and pelvic-band (B A), to which latter

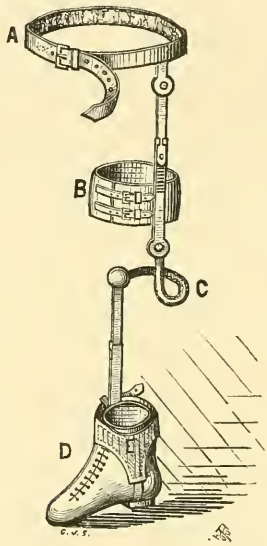
Fig. 27.



the shaft is united by a hinge, to which a screw is so applied as to permit of outward rotation of the foot to any required extent. This screw could not be easily shown in the woodcut.

Even after the discontinuance of these "retentive instruments," as they are called, I should recommend an elastic anklet to be worn, in order to prevent all possibility of a relapse. Its use is pleasant rather than irksome; and much more confidence is felt by the patient from the knowledge that such a support is present.

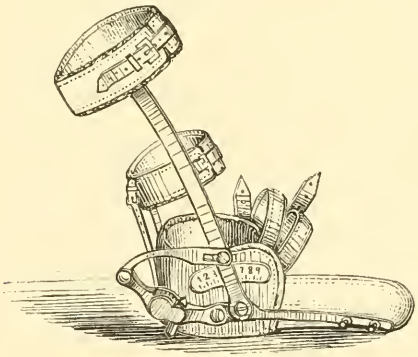
Fig. 28.



These, then, are all, so far as I know, of the really approved instruments for the treatment of talipes varus; many others, doubtless, there are, but those described are constructed on the most correct principles, and are best calculated efficiently to fulfil the objects for which they were designed.

Since this book was in the press, through the kindness of Dr. Little, I am enabled to add a particularly ingenious and useful form of shoe made by Mr. Ernst, under the direction of Dr. Little (Fig. 29). It consists of a metal sole and heel-piece, a spring running up the inside of the leg as far as a little below the knee, a calf-band, and other usual attachments. The improvement consists in the manner in which the shoe is acted in the

Fig. 29.



attempt to depress the heel. Reference to the diagram will show that the toe-spring is continued backward beyond the leg-spring, which is freely riveted to it, and bears a ratchet-joint acting upon a small arm projecting posteriorly upwards. Between two ears on the upper extremity of this lever a small curved arm is hinged, and is attached to the leg-stem by a screw passing through a slot near the malleolar axis. By turning the ratchet, the short

arm is made to describe the section of a circle, carrying the curved arm forward by reason of its freely swivelling, when this curved arm has been moved sufficiently forward, so as to press the end of the groove against the shaft of the screw by which it is secured to the leg-spring, and thereby tending to move it forward; but as this is firmly fixed to the leg, and the shoe is moveable, the heel is consequently depressed, and at the same time motion of the ankle-joint to the extent of the groove is permitted—a small engraved scale behind the leg-spring records the amount of depression; this is an ingenious and well contrived apparatus, and most efficient, as might be expected from the great experience and skill of its inventor.

CHAPTER II.

Talipes Valgus—Its various Grades—Characteristics and Causes—Liability to Increase from Neglect—Flat Foot—Its Appearance and Causes—The Mechanical Treatment of Talipes Valgus—Single Leg Instrument — Bigg's Shoe — Leg Instrument combining Ratchet and Free Ankle-Joint—Leg Instrument with Slotted Stirrup—Scarpa's Shoe—Scarpa's Shoe with two Ratchets.

Talipes valgus is the next distortion which demands attention. It must be carefully distinguished from talipes valgus spurius, or flat-foot, which it very much resembles. Its synonymes are βλαισος, platt-fuss, splay-foot, and pied-plat.

Talipes valgus is a rather common deformity: more so than equinus, less so than varus. It is rarely met with in its more severe or aggravated conditions, inasmuch as the pain and inconvenience caused by its earlier stages (much more than is produced by varus of equal or even greater severity) generally necessitate the application of remedial means before the distortion has passed into its worst phases.

Talipes valgus, similarly to talipes varus, is divisible into three grades of severity, each presenting a different external appearance, and im-

plicating different and additional muscles in its production and maintenance.

The first degree of valgus is very rarely met with. It consists of depression of the plantar arch, sinking of the inner ankle, and slight abduction of the toes. It is produced by paralysis or weakness of the posterior tibial muscle, and consequent contraction of the peroneus longus (Plate X., *a*), peroneus brevis (*b*), and peroneus tertius (*c*). This stage of the deformity is called, in common speech, "in ankle."

It is in its second grade of severity that valgus is most commonly seen. In this condition the arch of the foot is entirely lost, the whole of the sole being in one horizontal plane; considerable eversion of the toes is present, and the heel is slightly raised by the gastrocnemius and soleus muscles acting by the tendo Achillis (*d*), the ball of the foot presenting outwards instead of downwards. The inner malleolus falls greatly inwards and downwards, and a protuberance fills up the concavity naturally existing between it and the calcaneum, destroying the apparent lower projection of the inner malleolus; the outer border of the foot is also uplifted.

In this stage, in addition to the peronei, the extensor longus digitorum, gastrocnemius, and soleus muscles are contracted, considerable weak-

PLATE X.

Fig. 1

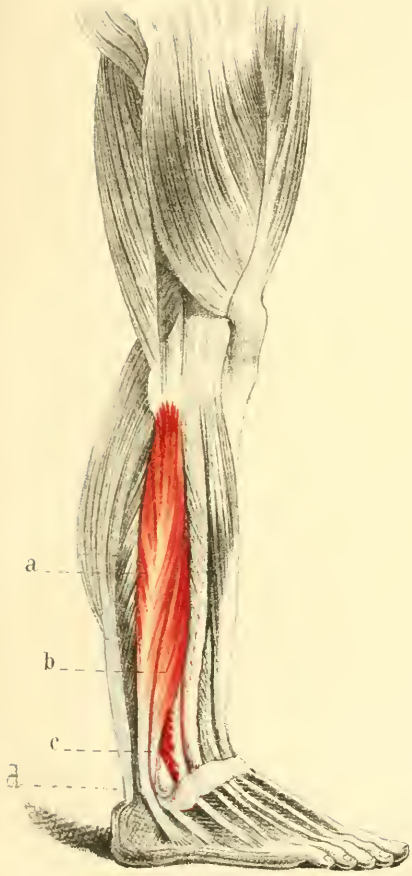


Fig. 2

S. Mercier del.

T. Underwood lith.

ness being observable in the tibialis anticus, which has given way in the attempt to supply the place of the tibialis posticus, rendered useless by paralysis.

Valgus in the third degree is a very rare occurrence; in it the heel is greatly raised and displaced outwardly, thus altering somewhat the position of the astragalus in relation to the tibia and fibula, and consequently "locking" the joint. The foot is also flexed, and the dorsum sometimes applied to the anterior portion of the leg, the toes being at the same time rigidly extended; the extensor proprius pollicis and abductor minimi digiti are retracted in this distortion, as well as those mentioned as being concerned in producing valgus of the second degree. Sometimes, from the extreme tension of the extensor longus digitorum, the sole presents a convex instead of a concave surface. As the abduction of the toes only affects the anterior portion of the foot, the scaphoid is left prominent on its inner border, and a convexity established where a concavity naturally exists, the reverse obtaining on the outer edge of the foot.

In contradistinction to varus, to which, indeed, valgus is in many respects the direct opposite, but little displacement and no alteration in shape takes place in the tarsal bones in this distortion. The scaphoid and cuboid are drawn downwards,

and the astragalus twisted in its articulation, and occasionally removed from its contact with the tibia, thus locking the joint.

Talipes valgus, if neglected, is, perhaps, more certain than any other deformity to increase by the use of the foot, which tends to depress, as far as possible, the plantar arch; it is at the same time a distortion which, especially in its earlier stages, very readily admits of cure. Mr. Barwell remarks with very great justice:—"We see many cripples about the world with the foot turned out, the leg shrivelled, and the whole body rendered crooked by their limping walk, who might have been enjoying their cricket or their shooting if the increasing nature of their malady had been earlier understood."

Before passing on to the description of the mechanism best calculated to effect the cure of talipes valgus, it will be proper to consider and describe the unsightly distortion called talipes valgus spurius, or, popularly, flat-foot, the two deformities being very closely allied, both in their external appearance and in the mode of treatment necessary for their relief.

Flat-foot may generally be distinguished from true talipes valgus by the fact that, in the former, the pain complained of by the patient is situated on the inner side of the sole, under the scaphoid

bone, whilst in the latter the pain is felt over the cuboid; also in flat-foot, although the concavity of the inner margin of the foot may be, and generally is, lost, the exterior border still retains the greater part of its convexity.

Flat-foot consists, as its name implies, of loss, more or less complete, of the arch of the sole, by means of which the whole, or an undue proportion, of the plantar surface is placed upon the ground. It is very rarely congenital, nor does it often occur in very young children, the usual time of its appearance being in adolescence, or at about the time of puberty.

Infants' feet have naturally very little arch, the concavity of the sole being formed when they begin to walk by the action of the peroneus longus, which depresses the metatarsal bone of the great toe. Sometimes the scaphoid and cuboid, which form the bridge or keystone of the arch of the foot, as it were, fall during this process, thus producing flat-foot. More frequently, however, the malady is found in adults, as a result of relaxation of the tarsal ligaments, frequently caused by rachitic weakness, assisted by excessive walking or standing. It is therefore most common among poor people, errand boys, and shopmen, whose avocations keep them constantly on their feet many hours in the day. Debility of the tibialis anticus is frequently a sup-

plementary cause of flat-foot. The great pain experienced in this malady is occasioned by the scaphoid and inner cuneiform bones falling and compressing the plantar nerve.

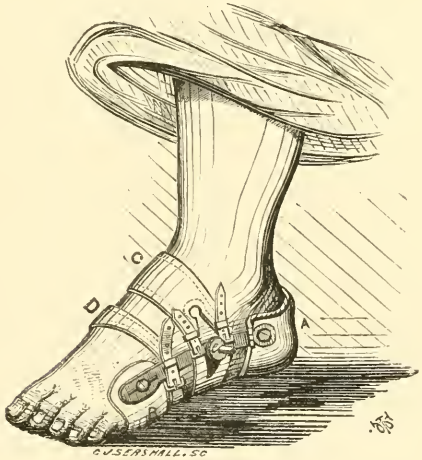
Talipes valgus being, as has been before observed, in many respects the direct opposite of talipes varus, it will not be surprising to find that most of the instruments employed for its relief are similar in construction, but reversed in their action, to those used for varus; hence the description of the appliances for valgus must necessarily be brief.

In the first stage of valgus, in which nothing but slight sinking of the inner malleolus and general weakness of the ankle is observable, it is usual to cause the patient to wear a boot strongly stiffened on the inner side, not a very satisfactory method of procedure. Frequently a light steel shaft is added (Fig. 12), running up the outside of the leg as high as the top of the calf, where it is pretty firmly secured by a padded metal band; and a V-shaped strap is attached to the inner side of the sole of the foot below the ankle, which bears a small crescent-shaped pad placed immediately below the inner malleolus, and is buckled outside the shaft, thus completely investing and supporting the ankle, whilst at the same time the leg-shaft prevents abduction of the foot. This little instrument, which is light, comfortable, and very easily con-

cealed, is perfectly efficient in most cases of incipient valgus. Where, in addition to the falling of the ankle, eversion of the toes is present, a toe-spring and strap are employed, as shown in the drawing (Fig. 12), except that for valgus the spring is applied on the inside instead of on the outside of the foot.

Similarly, also, several of the modifications of

Fig. 30.



Scarpa's shoe, already described, can be used with effect in the treatment of talipes valgus by simply reversing their action.

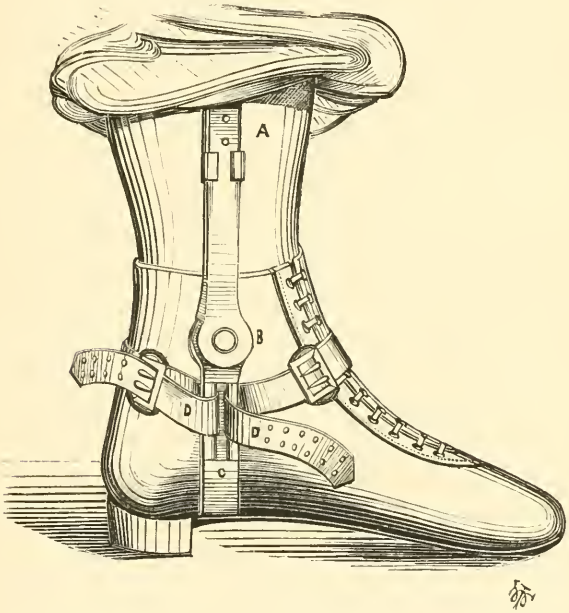
An instrument (Fig. 30) well calculated to effect the cure of valgus has been constructed by Mr. Bigg, and may be described as follows:—The hinder portion (A) of a metal shoe-piece receives

the heel, which is firmly therein secured by suitably-arranged straps; from the external side of the heel-piece projects a horizontal lever, jointed to it at the ankle, and resting against the outer and lower surface of the metatarsus by means of a padded plate (B); corresponding to the deepest part of the unnatural concavity on the external margin of the valgous foot under treatment is a ratchet-joint (E), from which a broad soft band (C) crosses the dorsum of the foot, embracing the projecting bones on the inner side of the foot, and is secured to its own superior extremity outside the ratchet, thus making the heel the fulcrum by means of which the screw exerts a gentle but firm and steady pressure against the toe-plate in order to adduct the anterior portion of the foot.

An instrument which I have found to answer admirably in cases where, from the humble position in life of the patient, no restraint can be put upon his movements which would interfere with daily labour, is thus made:—A steel shaft secured inferiorly to a strong boot runs up each side of the leg to a point four or five inches above the knee, being freely jointed opposite the knee and ankle, and padded troughs receiving the thigh and calf. Immediately below the outer malleolus is a ratchet-joint, which draws the ankle outwards and upwards by means of a V-shaped strap and crescent pad

similar to that employed in the first instrument described for valgus; a toe-spring is attached to the inner limb of the stirrup, which acts upon the everted metatarsus and phalanges by means of an arched strap springing from the outer margin of the sole of the foot, and coincident in position and

Fig. 31.

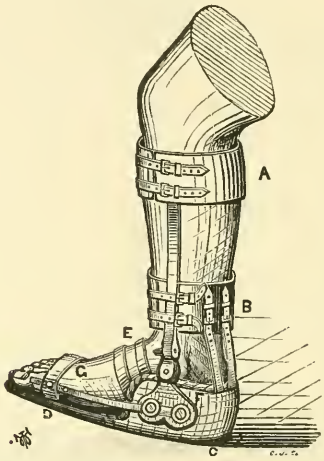


width with the length of the metatarsal bones. This instrument impedes none of the natural movements of the foot, but, on the contrary, tends constantly to restore it to its normal shape.

The apparatus shown (Fig. 31) is very useful in many cases of valgus not sufficiently severe

to require the application of the screw. It consists of a metal shaft (A) inserted into a boot and reaching to the top of the calf, to which it is held by a band, and jointed at the ankle (B); an arched strap is secured to the inner side of the boot beneath the malleolus, which it supports, the ends (D D) being brought round, passed through a slot (C) in the leg stem, reflected over it, and buckled to

Fig. 32.

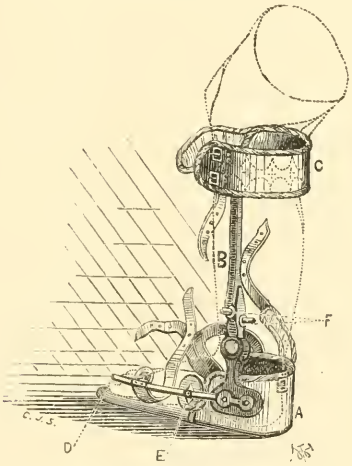


themselves. A toe-spring can be added if needed. By means of this contrivance the ankle is quickly restored to symmetry and strength.

None of these appliances, however, provide any means for depressing the heel; when this is elevated to any considerable extent by contraction of the calf muscles, the instrument (Fig. 32) may be used; it consists of a metal sole and heel-piece

(D F), from which latter arises, on the inner side, a steel shaft reaching as high as the top of the calf, where it is surmounted by a padded band (A); a band at the ankle (B) prevents the heel from rising on the application of a ratchet-joint (E) placed opposite to the tarsal articulation, and intended to depress the heel. A toe-spring and strap (G) are employed to evert the toes.

Fig. 33.



When any great obliquity of the sole is present, another instrument (Fig. 33) must be employed. This apparatus very greatly resembles the last described, except that a second ratchet is placed imdiately above the first (at F), to rotate the foot on its short axis and flatten the sole. With this instrument, which is only used in the worst cases,

a pad (E) resting against the projecting bones slides along the toe-spring (D) to assist it in its efforts to adduct the toes.

The remarks passed on the retentive treatment of restored cases of varus apply equally to valgus, the same instruments being used in both cases, but the straps being arranged for valgus so as to support the inner instead of the outer ankle.

Fig 1.

Fig 2.

S. Moreton del. T. Underwood lith.

CHAPTER III.

Talipes Equinus — Its Causes—Mechanical Treatment—Stromeyer's Foot-board—Shoe—Ratchet Instrument — Shoe with Plantar-Ratchet—Spring Instrument—Illustrative Litho-Photograph—Talipes Calcaneus—Its Causes—Mechanical Treatment—Spring Instrument—Biggs' Instrument—Talipes Cavus—Its Causes—Treatment—By Rubber Tendons—By a Shoe—Combinations of Talipes.

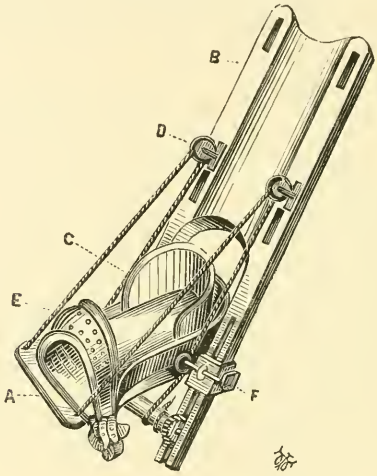
Talipes Equinus is the next deformity to be considered. This distortion is very rarely found alone; frequently with varus, less often with valgus. It consists of simple uplifting of the heel (Plate XI., Fig. 2), by the action of the gastrocnemius and soleus muscles (Plate XI., Fig. 1, *a*, *c*) acting by the tendo Achillis (*b*), the tibialis anticus and the peronei being wholly or partially paralysed; the toes are frequently rigidly flexed by the flexor longus digitorum.

Talipes equinus is capable of being successfully treated by mechanical means alone; but the cure is very greatly facilitated, and accomplished in a much shorter time, after the tendo Achillis has been subcutaneously divided.

Stromeyer's foot-board, which is the first instrument figured (Fig. 34, page 138), is a complicated

and almost obsolete contrivance, never or rarely introduced into private practice, but employed originally in hospitals on account of its being available for a number of patients; it consists of a wooden sole piece (A), on which the foot is placed and retained there by straps, moving on a free axis (F) between two vertical projections of a hollowed wooden splint

Fig. 34.



(B), laid against the back of the leg; the angle which the foot-board maintains with the leg-splint is regulated by an apparatus (D), similar to a winch and pulley, with a spring acting against cogs to prevent retrogression; this instrument is, in my opinion, clumsy, and ill-adapted to the office it is destined to fulfil; its construction entirely precludes

all exercise, and confines the patient in bed during its use.

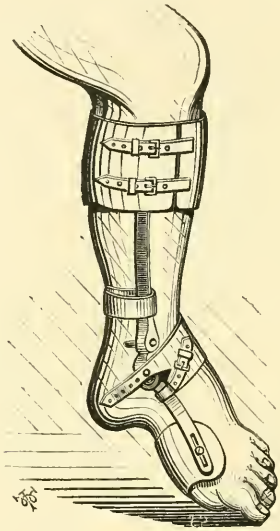
A better appliance is constructed similarly to the one shown (Fig. 19); in it a metal sole receives the foot, and forms the basis from which springs a shaft, placed usually on the outside of the leg for convenience of adjustment and manipulation, but as this deformity, when in its simple state, involves no lateral deviation from the normal shape of the foot, it is immaterial on which side the lever is applied; the leg-stem is secured to the calf by a padded band, and carries a lateral tangential screw at a point coincident with the tarsal articulation; a horizontal spring lies along the outside of the foot if any tendency to adduction of the toes is manifested; this instrument, when properly applied, very readily extends the contracted tendo Achillis; of course the foot is secured in the shoe by straps, and an ankle band is employed to prevent the heel from rising in the shoe when the ratchet-screw is turned.

Another useful apparatus (Fig. 35, page 140) consists of two lateral leg-stems, prolonged at an angle along the foot as far as the metatarso-phalangeal articulation, under which passes a broad padded plate united to each of the levers; a ratchet centre is placed opposite to the ankle-joint on each lever, and the apparatus is secured to the foot by a band

passing over the instep; this instrument serves admirably to raise the metatarsus and extend the plantar arch.

In cases where very great contraction of the plantar arch exists, an instrument (Fig. 36) is employed, which is constructed on the same plan as the instrument before referred to (Fig. 19); it differs, how-

Fig. 35.

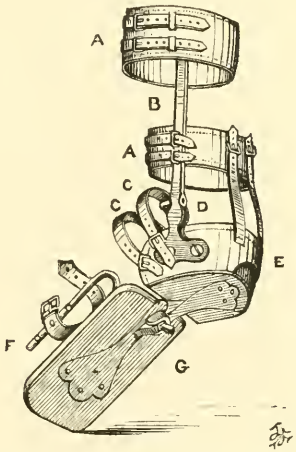


ever, in having the sole plate jointed below the medio-tarsal articulation, and a ratchet-joint (c) applied at the point of junction, which enables the operator to unfold the foot with ease and certainty; suitable straps passing over the dorsum of the foot and retaining it in position.

All these appliances, however, entail immobility

of the ankle-joint during treatment, and are therefore open to objection; consequently, in all cases except the most severe, I employ an apparatus (Fig. 37, page 142), which permits of exercise, and also of free movement of the articulation. In this instrument, a steel stirrup (E) is secured to an ordinary boot, and to it are jointed two lateral shafts (A), rising to the top of the calf, and having joints opposite the

Fig. 36.

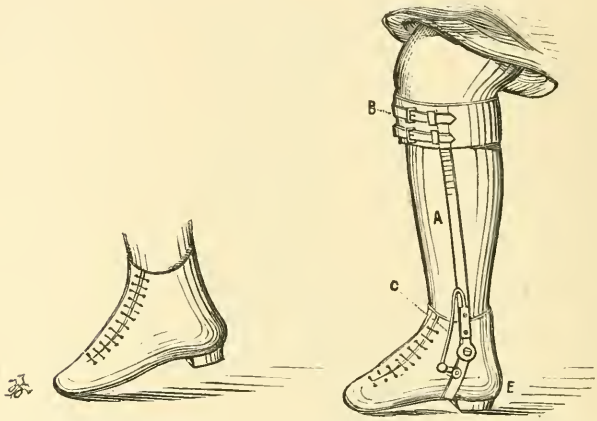


ankle, a padded calf trough (B) and an elliptical steel spring (C) immovably riveted to each leg-stem, and secured on a loose pivot to the stirrup, which its action constantly tends to depress, thus maintaining a firm and steady yet yielding and elastic strain upon the contracted tendon, which it never fails to elongate, at the same time it does not in-

terfere in any way with the movement of the ankle-joint; the same object may be obtained by stretching a rubber cord between the stirrup and the leg shaft, at a suitable degree of tension, the contractility of the rubber supplying the place of the steel spring.

The litho-photograph (Plate XII.) is introduced in order to show that the sketch given in (Plate XI.)

Fig. 37.



is not an exaggeration; it was taken from a patient sent to me from Leicester, who was mechanically treated with the greatest success, being able in a short time to place the entire foot upon the ground, instead of the metatarsus and phalanges only, as in (Plate XII.).

Talipes calcaneus, the last of this series of distortions, is at once the simplest and the rarest form

PLATE XII

of pedal deformity; it consists, when congenital (Plate XIII. Fig. 2), of involuntary and permanent flexion of the foot beyond a right angle, and is occasioned by contraction of the extensor proprius pollicis (Plate XIII. Fig. 1, *c*), extensor longus digitorum (*b*), and tibialis anticus (*a*), the tendons of the two former being seen as (*d* and *e*) in front of or below the annular ligament; the muscles of the calf are paralysed and atrophied. The synonymes of talipes calcaneus are hook-foot, heel-foot, hakenfusz, and pied-bot calcanien.

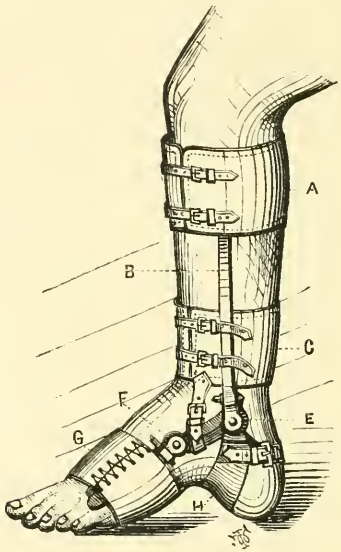
No relative displacement or change of the shape of the tarsal bones takes place in talipes calcaneus. When non-congenital, it is produced by paralysis or debility of the gastrocnemius, soleus, and plantaris; and in addition to the falling of the heel, the plantar arch is considerably raised and shortened, so as to enable the metatarsus to be applied at all events lightly to the ground; these conditions, however, more aptly belong to talipes cavus, presently to be described.

In ordinary cases of calcaneus, an instrument is used similar to that employed for equinus (Fig. 37), except that the action of the springs is reversed, so as to raise the heel instead of depressing it; otherwise the rubber cords may be used in the same manner, their lower ends being fastened to the heel of the boot instead of to the stirrup. Some-

times a Scarpa's shoe with a lateral ratchet is used, the action of the latter being of course reversed; an instrument of this kind is seen (Fig. 19).

In severe cases, an instrument (Fig. 38) designed by Mr. Bigg is of great service; it is, however, more suited for cavus than for simple calcaneus. It is thus described by its inventor:—

Fig, 38.



"To the lower extremity of a perpendicular stem (B), which passes down the leg on its outer side, and in coincidence with the malleolar axis, a rack and pinion centre (E) is attached, from which there proceeds a small arm of metal supporting a plate (H), which is accurately moulded to the anterior

PLATE XII

Fig 1

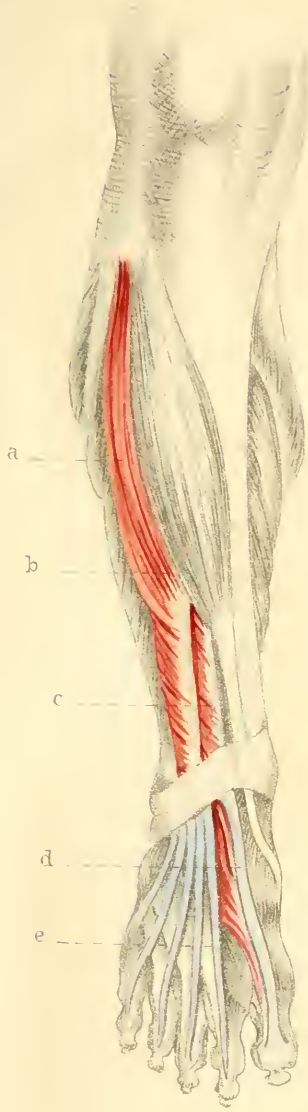


Fig 2

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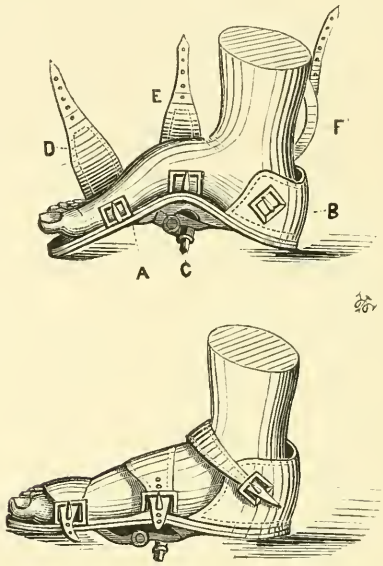
Underwood lith

surface of the calcaneum. Since this stem is the radius of a circle formed by the malleolar axis as a centre, with the extremity of the calcaneum as a point in the circumference, the arm necessarily moves backwards and upwards. Another stem, which is carried to the extremity of the metatarsus, and bears a plate (G) into which the plantar surface of the metatarsus and the proximate phalanges are received, is placed towards the front of the ankle-joint; finally, another rack and pinion centre (F) is established in the foot-stem, just opposite the calcaneo-cuboid articulation, which uplifts the anterior portion of the foot by its action, for the stem becomes a radius to a circle which involves the anterior portion of the foot. By these two actions the plantar arch is gradually expanded and the foot restored to its natural position."

Mr. Barwell, in his work on club-foot, from which several quotations have already been made, describes and represents by photographs another form of talipes, not usually recognised as a distinct species of deformity, but rather considered as a certain condition of calcaneus; this distortion he calls talipes cavus. It is characterized by extreme uplifting of the tarsal arch, due chiefly to upward displacement of the navicular bone, together with slight obliquity of the sole. It is produced by paralysis of the gastrocnemius and soleus muscles,

which allow the heel to descend, and in consequence the whole weight of the body to fall upon the posterior portion of the calcaneum, which greatly increases in size, instead of, as in the normal position, on the ball of the heel; at the same time the peroneus longus draws down the

Fig. 39.



anterior portion of the tarsus and the base of the first metatarsal bone.

This deformity may be treated in two ways, either of which is very simple: the rubber tendon system may be applied, the calf muscles and the tibialis anticus being assisted, or the instrument shown (Fig. 39), taken from Dr. Little's work, may

be employed. This apparatus consists of a metal sole (A) accurately adapted to the configuration of the foot, to which it is properly secured by straps (D E F), assisted by a heel-piece (B); the sole is jointed immediately below the medio-tarsal articulation, and a ratchet centre (C) placed at the point of junction, by means of which a soft strap (E) passing over the scaphoid and cuboid bones, speedily corrects the deformity. This apparatus may be worn inside a boot which I have designed for that purpose, having a thick sole and heel, and a pit for the reception of the spindle of the ratchet. The second figure of the diagram shows the instrument applied, and its power to depress the excessive arch of the sole.

Respecting the combination of these different forms of talipes among themselves: equino-varus and equino-valgus we have already met with; any other combinations are rare, and when they do occur, require no special forms of apparatus for their treatment, the facility of application and adaptation found in all well-devised and carefully-constructed instruments for varus and valgus enables them to be at once applied to any of the modifications of the distortions just described.

CHAPTER IV.

Rachitic Distortions — Genu Valgum — Characteristics — Mechanical Treatment—Simple Splint—Leg Instrument—Lever Instrument —Instrument with Knee Ratchet—Salt's Instrument with Ratchet and Free Knee-Joint—Case showing its Application—Barwell's Plan—Salt's Modification of the same—Genu Extrorsum—Its Characteristics—Mechanical Treatment—Splintage—Leg Instrument—Case of Genu Extrorsum—Genu Extrorsum of one Leg with Genu Valgum of the other—Inflected Tibiæ—Treatment of Lateral Inflexion—Illustrative Case—Antero Curvature—Treatment — Case — Antero-Lateral Curvature—Treatment—Desirability of Dividing the Treatment into two Stages—Its Success.

We now turn to a different form of distortion from those embraced under the general head of "Talipes," namely, genu valgum, genu extrorsum, inflected tibiæ, &c., all of which are principally the result of a rachitic condition of the system.

Taking them in the order in which they are mentioned, genu valgum (knock-knee, or in-knee) first presents itself to our notice. It consists of an inward inclination of one or both knees, permitted by extension of the internal lateral ligament of the knee joint, and increased by the superincumbent weight of the body. It s one of the most common forms of rachitic distortion, and is frequently found in

conjunction with contraction either of the knee or of the hip joint.

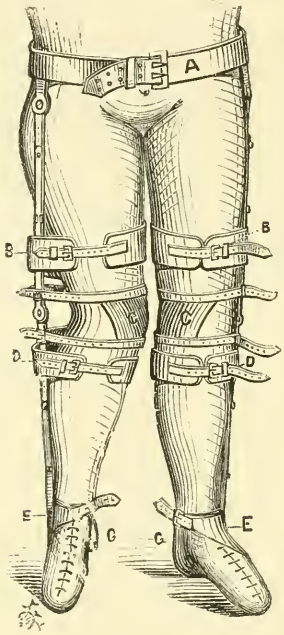
The only displacement or alteration in position of the bones observable in knock-knee is that the inner condyle of the femur quits its close approximation to the inner tuberosity of the tibia. The angle formed by the inward inclination of the knee, between the leg and thigh bones, causes the outer margin of the foot to be raised; in order to compensate for this, and to allow the foot to be again placed flat upon the ground, it is rotated inward, by leaving the outer malleolus prominent, in a manner similar to talipes varus, and more or less severely according to the angle maintained by the diverging limbs.

The treatment of knock-knee (mechanically) is, perhaps, the simplest problem offered for solution to the Orthopædic Mechanician, and provided due care is employed by him at and after the time of applying mechanical supports, a cure may be considered certain, that is, provided that the means suggested by the surgeon for strengthening the bones and improving the general condition of the health are regularly and carefully attended to.

The most elementary contrivance for reducing the leg to its normal shape, consists merely of a straight splint applied on the outer side of the limb from the hip to the ankle, and tightly bandaged to

the leg, especially opposite the knee-joint; this simple contrivance would, in slight cases, answer sufficiently well if it were not for the risk of inducing ankylosis by long retention of the limb in one position; the patient, too, if able to walk, is very liable to stumble and fall when encumbered

Fig. 40.



with his splints, and thus is in constant danger of fracturing the bones of the thigh or leg; this plan, therefore, is now almost entirely discarded.

The next appliance (Fig. 40) consists of a lateral leg-stem attached to the outer side of each boot

(if the deformity be double), and carried up the limb to about two inches above the hip joint, where it is surmounted by a padded pelvic band (A) which unites the two shafts; it has lateral joints opposite the hip, knee, and ankle; an elastic knee cap (C) embraces the knee, and being tightened by straps passing outside the shafts, gradually approximates the limb to its natural position; this instrument answers better, and has very much more power over the leg, when it is provided with padded metal bands at the thigh and calf (B D). A strap (E) is used to support the malleolus of each foot.

An instrument which I do not much approve of, though employed by some mechanicians, is constructed on a principle based on the supposition that in knock-knee the tibia moves beneath the femur, which does not change its position relatively to the os innominatum; I am perfectly convinced that both bones move on their respective axes, the thigh on the hip, and the leg on the foot, and therefore that such an instrument cannot properly fulfil the desired conditions.

The instrument referred to consists of a steel lever securely fastened by a band to the inside of the thigh, and bearing a large padded ring resting against the knee; to this ring a second lever is jointed, so as to admit of movement only in the natural plane of the joint; the second lever is

placed as nearly as possible in the same relation to the first as the tibia should have to the femur, both being in their normal position; to the lower lever a band is attached which encircles the calf, and draws it towards the median line.

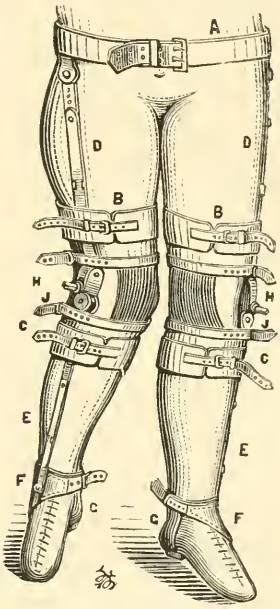
This instrument, besides being, as I consider it, incorrect in theory, must be very inconvenient for wear; unless the angularity were very great indeed, the patient would be constantly knocking his other leg against the lower lever and abrading the skin.

Another instrument usually employed in very severe cases is constructed with a lateral steel shaft inserted into a boot, jointed at the hip and ankle, and having calf, thigh, and pelvic bands; thus far, it resembles an instrument previously described, but instead of having a free joint at the knee, a ratchet centre is placed there, acting at right angles to the plane of natural motion; by means of a strong but soft knee-cap this ratchet gradually straightens the limb.

I have devised an instrument (Fig. 41) for knock-knee exactly similar to that last described except in one particular, and that a novel and important one; in the old form, in cases so severe as to require a screw apparatus for their reduction, no motion whatever was allowed to the knee-joint, thus rendering locomotion tedious and difficult, besides incurring the risk of stiffening the joint. The appa-

ratus I have designed will obviate these objections; immediately below the ratchet (H), and in a plane at right angles to its action, that is, in the plane of natural movement of the knee, I place an ordinary lateral joint (J), which readily admits of flexion and extension of the knee.

Fig. 41.



It may be objected that the centre of its motion is not coincident with that of the articulation it is designed to assist; this is perfectly true, but I have found by experience that the slight deviation referred to (not more than a quarter of an inch) is of no practical importance, and does not interfere in

any way with the action either of the limb or of the instrument. Of course, this principle cannot be applied in cases in which genu valgum is combined with contraction of the knee-joint; in such instances a second ratchet must be employed, acting at right angles to the first; these two movements are sufficient to remove almost any deformity.

Plate XIV. is introduced to show the application of the instrument (Fig. 40). Fig. 1 shows the state of the child's leg when placed under my care; Fig. 2, the position it quickly assumed on application of the support, with very slight tension by means of the ratchet, both examples being photographed the same day.

Mr. Barwell has suggested a plan of treatment, which, in cases of slight genu valgum, theoretically viewed, appears likely to be useful, if its general adoption be not prevented by reason of the time and trouble required in its successful application.

He is in the habit of using thin flat steel springs about No. 10 gauge, and from one and a quarter to one and a half inch wide, jointed at the middle (by a hole for the insertion of a pin to prevent the joint bending during their application), bent with the aid of a clamp (Fig. 41, C D) to a curve a little exceeding that taken by the inflected knee. Whilst retained by the clamp in this curve they

PLATE XV

Fig 1

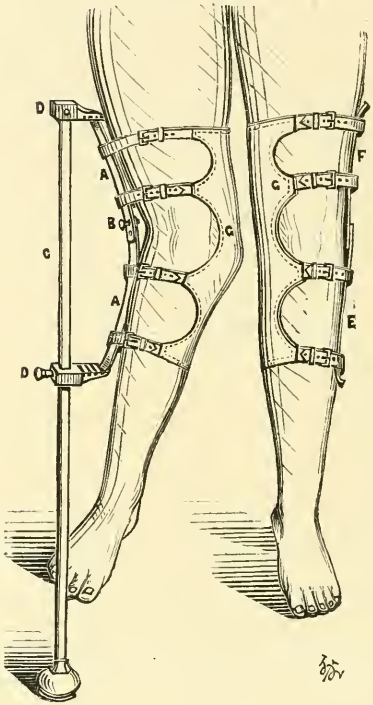
Fig 2

are tightly bound to the limb by means of strong adhesive plaster, which completely envelopes and swathes the leg from the thigh to the toes; the retaining clamp and pin are then removed, and the spring thereby released. This spring is constantly exerting its force to recover its original straight position, and, being bound to the leg, draws that with it; when it is desirable to concentrate the force of the spring on the knee, or to protect the skin from the traction of the plaster, Mr. Barwell employs leather splints, moulded to the shape of the leg. I may, perhaps, be allowed to suggest, as the result of experience, that gutta-percha of the requisite thickness would be much more manageable.

I have adopted a modification of Mr. Barwell's plan (Fig. 42, p. 156). From a glance it will be seen that the adhesive plaster is superseded by a leather pad (C), furnished with four straps, which lies along the inside of the leg. The four straps pass over the flat spring (A A), each hooking on to a stud on its surface, and buckled in front of it, the spring having been bent, as I before stated, in the clamp (B), which consists of an iron rod (C) having two notched projectures (D D), one fixed and the other moveable, by the approximation of which the spring may be bent to any desired amount of curvature.

Genu extrorsum, or bowed legs, is a form of distortion exactly similar in character and origin, though opposite in external appearance, to genu valgum. As knock-knee consists of inward, so

Fig. 42.



genu extrorsum consists of outward inclination of the knee, but with this difference, that while genu valgum may appear either as an angular or as a curved inclination, genu extrorsum is always found in a curved shape, both the femur and the tibia

PLATE XV

being deflected from their straight position. It is accompanied by relaxation of the external lateral ligaments of the knee-joint.

The causes of all curvatures of the shafts of the leg bones are the same, namely, the presence of an inordinate proportion of animal matter in their composition, or the result of a rachitic condition of the whole system; which, by making the bones softer than they would be in a healthy condition, causes them to yield beneath the superincumbent weight of the body; this is especially evident in inflected tibia, of which hereafter.

The mechanical treatment proper to be adopted for the cure of genu extrorsum is very simple, but one desideratum being required, namely, expansion of the arc of curvature; the principle by which this is effected—*i.e.*, pressure on the vertex of the arc, with counter resistance at its extremities, remains the same in all appliances, but the modes of its application greatly differ.

The most elementary contrivance which has been employed for effecting this object is simply a flat padded wooden splint, resting against the upper and internal portion of the thigh, and by the intervention of a very soft cushion against the inner malleolus. This splint is securely bound on to the leg, the greatest amount of pressure being applied over the vertex of the arc of distortion. It is

found in practice extremely difficult to prevent this splint from losing its position, and getting behind the leg instead of on the inner side of it, which, of course, entirely neutralizes its action.

A better instrument consists of a metal shaft riveted to the sole of a laced boot, and carried up as high as the upper third of the inside of the thigh, having a joint at the knee and ankle, and also broad padded troughs to receive the thigh and calf. A broad elastic knee-cap supports the knee, which, being tightened by straps passing round the shaft, gradually reduces the distorted arc; at the same time the action of the knee and ankle is not at all interfered with.

I disapprove altogether of the plan sometimes adopted of fastening the stem to the boot by means of a tubular socket in the heel, as the security and increased power arising from its being firmly riveted in its proper position much more than counterbalance, in my opinion, the convenience derivable from the power of detaching the instrument from the boot, the only benefit which could possibly accrue from the employment of the socket fastening.

The instrument as described above was employed for the patient whose limbs are shown (Plate XV.), a very severe case, with what result will be seen by reference to Plate XVI., which is from a photograph

PLATE XVI

taken some time after instrumental support had been discontinued; and also to the letter, No. 18, received from the patient's father, in answer to a request for a photograph of the present state of the child's limbs.

A case occasionally presents itself in which genu extrorsum of one leg is combined with genu valgum of the other. This is one of the most unsightly deformities to which the limbs are liable, occasioning greater lameness and inconvenience than almost any other distortion, unless, indeed, it be some of the severer grades of talipes. The support of the body being thrown entirely to one side, the efforts of the body to maintain the centre of gravity very frequently, nay, almost invariably, cause obliquity of the pelvis, and consequent curvature of the spine; this, however, will usually be spontaneously rectified on the restoration of the limbs to their proper shape, unless very great debility or general rachitic weakness of the system be present; mechanical aid may then be necessary to effect a cure, but this is not often required.

The proper means to be employed in the treatment of such cases is to adapt to the leg which curves inwards one of the instruments figured for genu valgum, and to the leg curving outwards, the instrument employed for genu extrorsum, with the addition of an external lateral leg-stem jointed

opposite the ankle, knee, and hip, having padded thigh- and calf-troughs, and a band which encloses half the pelvis, and is buckled in front and behind to a similar band attached to the other instrument; in these instruments, by tightening the back straps, the toes are directed outwardly, and thus may be conquered any tendency evinced to inversion of the toes.

Mr. Barwell's plan of using steel springs attached to the limb by adhesive plaster, or my modification of it, is applicable to genu extrorsum as well as to genu valgum, the springs in this case being applied on the inner instead of on the outer side of the leg; but I do not consider them equally reliable.

Inflected tibiæ, or crooked legs and shins, are the next deformities to be noticed; they consist of curvature of the leg bones on their long axes, and may occur either laterally or anteriorly; inward curvature is, however, very rarely if ever seen. Such distortions invariably result from rachitic conditions.

The treatment of lateral curvature of the tibiæ is very simple, all that is required being to place a shaft as a chord across the arc of curvature, with suitably arranged straps to draw the tibiæ to it.

For this purpose I usually employ a steel shaft carried up each side of the leg, the outer reaching to a little above the hip, the inner to a few inches

PLATE VII

above the knee, a soft pad being interposed between it and the inner condyle of the femur, to prevent abrasion when used as a fulcrum ; a softly-padded band surrounds the leg at the vertex of its arc of curvature, and draws it towards the inner leg-stem, outside of which the band is buckled ; a V-shaped strap supports the outer ankle.

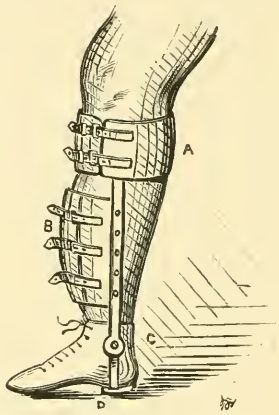
The outer shaft may be considered unnecessary and superfluous, but I have found from experience that the additional support it affords very materially aids in strengthening the limb, and thereby diminishing the time occupied in the treatment; if the second shaft be dispensed with, a single one carried as high as the condyles, against the inner of which it rests, is all that is required, the band to draw the tibia to it being of course retained. A case of inflected tibiæ which was successfully treated in the former way is represented (Plate XVII.).

The treatment of anterior curvature is not so easy as that of lateral, owing to the difficulty of obtaining a fixed point behind the leg from which to draw the tibia backwards; I usually employ an instrument (Fig. 43, p. 162), consisting of two metal shafts, one on either side of the leg, secured to a boot, reaching to the top of the calf, and having lateral ankle-joints (C), and a padded calf-trough (A); opposite the point of greatest curvature, and for

some distance above and below it, a short padded band (B) is secured to each shaft; these meet over the front of the leg, where they are buckled with as much pressure as can be conveniently borne; increased gradually as the curve decreases; a padded cushion is placed between the band and the tibia to prevent abrasion of the skin.

An instance of rather severe anterior curvature

Fig. 43.



of the tibiæ is shown (Plate XVIII.); this was very obstinate and difficult to treat, resisting for a long time all mechanical treatment; eventually, however, the limbs were completely restored to their normal state.

Where lateral and anterior curvature are combined, I prefer dividing the restorative process into two stages, one for the lateral and one for the

anterior curve; the same mode of treatment being adopted for each as if it had occurred separately.

Should it, however, be determined to attempt the cure of both simultaneously, steel shafts with stop-joints at the ankle are carried up both sides of the leg as high as a few inches above the knee, where they are united by means of a padded metal thigh-trough; a band of metal also unites the two stems immediately behind the arch of curvature, having slits through which a broad webbing strap passing over the curved tibia can be attached; this web strap passes also through slits in a leather band which encircles the leg, and is attached to the inner leg-stem, being intended to correct the lateral curvature; this apparatus rarely fails in accomplishing the desired end, but in my experience very little if any time, is saved by combining the treatment of both forms of distortion at one and the same time, whilst the mechanical difficulties of the case are very greatly increased.

In all cases of rachitic weakness of the ankle I recommend an elastic sock to be worn, both during the treatment, which it very materially assists, and also after its completion, in order to prevent any undue strain upon the recently-developed and still feeble muscles and ligaments, until they have acquired sufficient strength and elasticity to bear it with impunity.

After the cure of genu valgum or genu extrorsum, I apply a light knee-cap having a thin metal shaft on the centre of each side, jointed at the middle, so as to permit all natural movement, but resisting any efforts of the limb to lateral deviation; this support should be worn for a considerable period after the discontinuance of active treatment.

PLATE XVIII

CHAPTER V.

Contracted Joint — Definition —Causes—Splintage — Contraction of Flexor Muscles—Distinction between Ankylosis and Contraction—Contraction of the Hip Joint—Causes—Difficulty of Successful Treatment — Elastic Cord Instrument — Spring Instrument—Reclining Couches—Ratchet Instrument—Contracted Knee—Causes—Liability to Occurrence of Subluxation during its Mechanical Treatment—Screw Instrument—Its Action—Ratchet Instrument—Elastic Cord Instrument—Double Ratchet Instrument —Erichsen's Apparatus for Subluxation of the Tibia, with his own Explanation—Contraction of the Toes.

Contraction of a joint is a deformity of rather frequent occurrence, and consists of the approximation of the free extremities of two bones which form an articulation, or, to speak more briefly, of a persistent state of flexion of the joint; in this position the bones are retained, that is to say, further flexion may be, and generally is, permitted, but extension to the nominally straight position of the limb is prevented; this contraction may be slight and scarcely perceptible, may occur at a right angle, or may be so severe that the shafts of the approximated bones are almost parallel with each other.

This state of rigid and persistent flexion is produced and maintained by shortening of the flexor

muscles of the contracted joint; this contraction of the muscles may be produced by long retention of the limb in one position, as in lengthened splintage after fracture; by paralysis of the extensor muscles of the joint, which allows the unaffected organs to obtain a powerful preponderance; by spastic action of the contracted muscles, or by the cicatrices of wounds or burns, which, by approximating the surrounding tissues, cause contraction of the joint, and subsequent structural shortening of the flexor muscles; and frequently, on removal of the primary cause, it is found impossible to completely straighten the limb, which is then said to be contracted.

The causes of contraction may be distinguished from those of ankylosis by their acting at a distance from, and independently of, the articulation, and only secondarily affecting it, whilst ankylosis is produced by causes immediately and primarily affecting the joint.

To determine whether a deformity be ankylosis or contraction is a very difficult matter, requiring careful examination and delicate manipulation. The point to be determined is whether the joint is susceptible of any movement; if it is, it is contracted, if not, it is ankylosed; this, however, is the province of the surgeon, not the mechanician.

It is frequently also of great importance to discover what is the nature of the obstacle which prevents the straightening of the limb, whether it is muscular contraction or osseous growth; this is best ascertained by careful manipulation, feeling whether the leg is extended with an evenly increasing strain, until as much force as is prudent has been applied, in which case it is muscular; or whether it comes to a sudden stop after traversing freely the intervening space, when it is probably osseous. It is more particularly important that a correct diagnosis should be arrived at as to whether the deformity in question be ankylosis or contraction, as the mechanical treatment proper to be employed for one is unsuitable to the other; thus much having been decided by the surgeon, the case falls under the care of the mechanician.

Many articulations are liable to contraction, especially those of the hip, the knee, and the phalanges, contraction of the ankle being comparatively rare, and is referable when it does occur to talipes calcaneus. Taking them in order, the first is contraction of the hip-joint.

Contraction of the hip-joint is produced by shortening of the flexor and adductor muscles of the thigh, the lower part of which is, by their action, approximated, nay, sometimes even closely aligned to, the trunk. The muscles which produce this con-

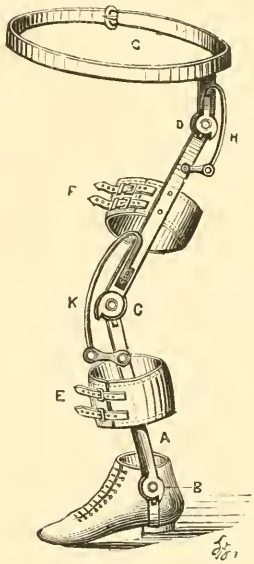
dition are the adductores, longus, brevis, and magnus, the pectineus, rectus femoris, sartorius, and gracilis.

This distortion is a very difficult one to treat, on account of the femur being united to the pelvis by a curved neck, instead of without such intervention, as at the knee-joint; this arrangement of the articulating process of the femur, although advantageous in an anatomical point of view, causes it, when constantly flexed, to exercise an unnatural and injurious pressure against the capsular ligament of the hip-joint, which aids its further displacement; so that in hip-joint contracture of great severity and long standing it is not uncommon to find three deviations of the femur from its proper position, namely, contraction, adduction, and inward rotation.

The instruments which have been constructed for the relief of this deformity are not many in number, nor are they quite satisfactory in their action; slight cases may be sometimes successfully treated by means of the tension of elastic cords properly applied. For this purpose an instrument is constructed consisting of two lateral elongating crutches, supported on a pelvic band, from which depends, on the side of the contracted limb, a metal shaft reaching as low as the middle of the calf, freely hinged at the hip and knee, and bound to the thigh and calf by padded bands. A small metal

plate rests against the back of the hip to act as a fulcrum. From the upper extremity of the thigh-shaft a prolongation is carried posteriorly outwards, from the termination of which a strong rubber cord or ring is stretched to a point on the pelvic band behind and above the articulation with considerable tension; this instrument answers admirably

Fig. 44.



in very slight cases; but unless the lesions be small and recent, sufficient power cannot be obtained by this method to effect their resolution.

Occasionally steel-spring power is employed in lieu of elastic; in which case an instrument (Fig. 44) is used, consisting of a pelvic band (c) attached

to a shaft (A), prolonged downwards till it terminates in a boot. It is freely hinged at the hip, knee, and ankle (D, G, B), and secured to the limb by padded thigh and calf-troughs (F E), the metal part of the thigh-trough being placed before, and of the calf-trough behind the leg. A powerful spring (H), of somewhat elliptical shape, is placed at the hip-joint (D), the force of which tends constantly to straighten the limb. In cases where contracture of the knee is coexistent a similar spring (K) is placed at the knee-joint.

Very frequently, as I have before stated, contraction of the hip is accompanied by inward rotation of the femur, in such a manner as to cause its head to lose the relative position it occupies to the acetabulum in the normal state, this displacement sometimes amounting to total dislocation, and causing a diminution in the length of the limb. To this deformity is sometimes added contraction of the knee, and, occasionally, one form or another of "talipes."

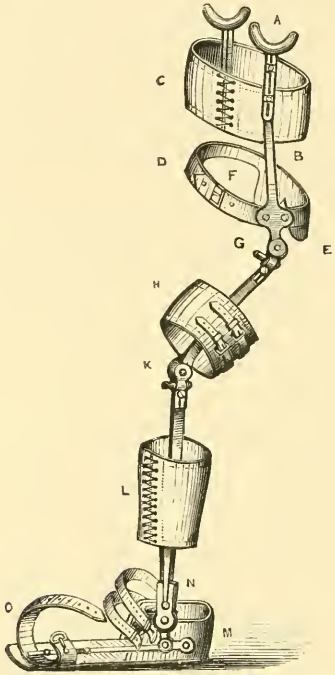
When one or more of these complications are present it becomes necessary to employ an apparatus possessed of movements corresponding with, and opposite to, those by which the limb acquired its deformed position. To effect this purpose many reclining couches, some of them very ingenious, have been devised, especially one by Dr. Heine, of Wurtemburg, with which, by means of a compli-

cated arrangement of winches and pulleys, the limb is gradually extended in the desired directions. All of these, however, entail constant confinement in the recumbent posture, which is not only irksome to the patient's temper, but also very injurious to his general health. The apparatus I am about to describe (Fig. 44) possesses the power of fully and completely restoring cases of very severe and complicated contraction, at the same time that it admits of considerable exercise being taken with the assistance of crutches.

This apparatus (Fig. 45) is thus constructed: a metal band (D) encircles the pelvis, and from it springs, on the side which is the seat of the disease, a tolerably strong crutch (B), so constructed as to admit of being raised or lowered at will; the crutch is firmly held to the body by means of a strong but soft webbing band (C), passing over the chest and behind the back, while a crutch of lighter construction rises from a socket in the band and supports the other axilla; a gluteal plate (F E) is attached to each side of the pelvic band to form fulcra, which may support the pressure to be exercised on the limb; from the pelvic band, on the affected side, depends a powerful steel shaft, which descends the outside of the leg to the ground, or to the extremity of the limb, if the contraction is so great as not to admit of the foot being placed on

the ground; the inferior extremity of the shaft is received into an ordinary boot. At the hip-joint one, two, or three ratchet-centres are placed according to the number of deviations the thigh has assumed from its natural position; the first extends

FIG. 45.



the thigh upon the pelvis, the second draws the femur outwards, and the third rotates it outwards. When dislocation of the head of the femur, and consequent shortening of the limb is present, a male and female screw is arranged between the hip and the knee, the traction of which elongates the

limb; this arrangement, and the combination of ratchets, have, for the sake of simplicity, been omitted in the drawing, as they are very rarely required; if the knee is contracted, a ratchet (K) is placed there, and if any form of talipes is superadded, the boot is exchanged for a modification of Scarpa's shoe, supplied with rack pinion actions suitable to the class of deformity exemplified in the case; of course in this, as in all other instruments of the kind, a padded metal trough (H) is placed in front of the thigh, and another (L) behind the calf.

I find it advisable in this instrument to add a leg-stem on the unaffected side, freely hinged opposite the articulations, and united above to the crutch, as any artificial support afforded on one side of the body only, tends, unless suitably counteracted, to produce inclination towards the other side, inducing either genu valgum, lateral curvature of the spine, or a combination of the two.

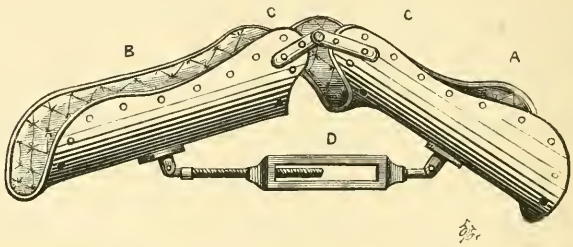
The instrument above described is one of the most complete appliances in orthopædy, and if properly designed, so as to meet the peculiarities of the case under treatment, and carefully constructed, few cases are so severe and obstinate as to preclude the possibility of being relieved.

Contraction of the knee-joint is a deformity of very common occurrence, it is caused by shortening of the ham-string muscles, namely, the

gracilis, sartorius, semi-tendinosus and semi-membranosus, together with the popliteus.

A peculiar feature of contracted knee, which renders its mechanical treatment somewhat more difficult than from the simple nature of the deformity would at first sight be apparent, is a tendency to the occurrence of posterior luxation of the head of the tibia beneath the condyles of the femur on the application of the pressure necessary to straighten the limb; this circumstance is over-

Fig. 46.



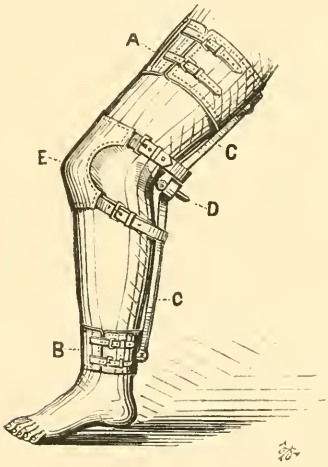
looked in the principles according to which many instruments for contracted knee are constructed, and hence, although they may succeed in straightening the limb, the patient frequently derives no benefit, but rather injury, from the treatment employed.

The first and simplest instrument for this deformity (Fig. 46) exemplifies this very clearly; it is constructed of two padded metal troughs (A B), one of which receives the thigh, the other the calf, and which are united by hinge-joints (C), opposite

to the articulation of the knee, the prominence of which is embraced by a strong knee-cap; a male and female screw (D) connects the posterior surfaces of the two troughs, and increases or diminishes the angle which they form with each other; the troughs are secured to the limb by padded bands passing over the front of the thigh and leg.

Now, as the femur serves as a fixed point by

Fig. 47.



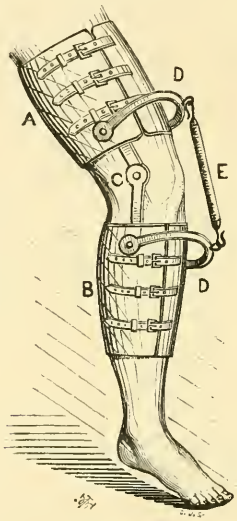
which the action of the lower part of this apparatus may be exerted, the whole force of it tends to press forward the lower part of the tibia, causing corresponding backward movement of its head; this is sometimes so extensive that the anterior portion of the tuberosities of the tibia lies behind the condyles of the femur.

This instrument is sometimes varied (Fig. 47)

by exchanging the metal troughs for two levers (C C), united to the thigh and calf by padded bands (A B), and having a ratchet-joint (D) immediately behind the knee, an elastic knee-cap (E) being employed in this, as in all other contrivances for knee contracture.

Sometimes the tension of elastic cords is employed

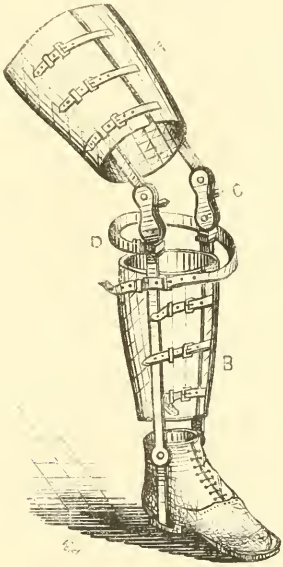
Fig. 48.



as a substitute for the screw (Fig. 48); in this instrument the leg and thigh are, as usual, received and secured in padded metal troughs (A B), connected by lateral levers, jointed opposite the knee (C); to one side of the lower extremity of the thigh-trough, and of the upper extremity of the calf-trough, two bridges of metal (D D) are hinged,

a knee-cap being placed between them; when the leg and thigh have been secured to the apparatus, these bridges are brought over and fastened to their respective troughs on the outer side by an ordinary spring catch; a loop is made on the centre of each for the attachment of a strong rubber cord (E), pro-

Fig. 49.



portioned in its length and thickness to the amount of force required to be exerted; this apparatus answers admirably in cases of slight or even average severity, but is not applicable to severe and long-standing contracture. In such cases, an instrument (Fig. 49) is used which consists of two lateral shafts attached to

a boot, jointed at the ankle and carried up to the upper third of the thigh; strong and broad bands (A B) receive the thigh and calf, and a knee-cap covers the patella; a ratchet-joint (C) is adapted to each stem opposite the knee, and to prevent subluxation, a webbing band (D) is carried from one shaft to the other immediately behind the head of the tibia and buckled pretty tightly; this instrument is capable of restoring the most severe cases.

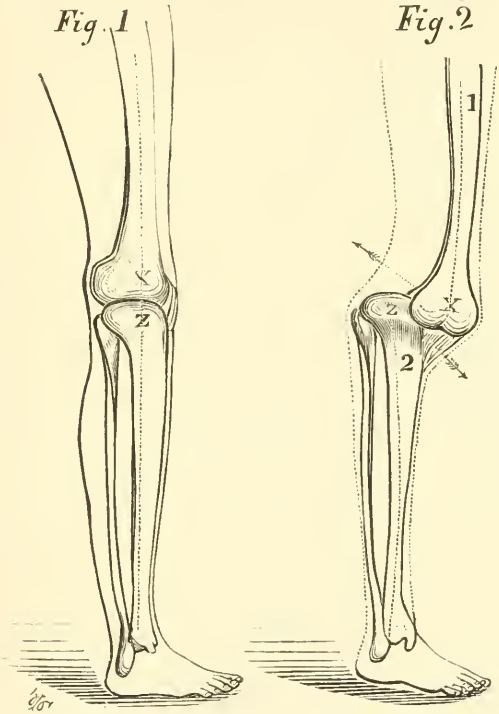
A very useful apparatus for posterior luxation of the head of the tibia, constructed in the first instance by Mr. Bigg, was devised by Mr. Erichsen, and described by him in the *Lancet* for 1856. I extract the woodcuts (Figs. 50, 51) in illustration, and also a part of the letterpress description:—

"The diagram, Fig. 50 (2), represents the limb of a patient whose tibia has become displaced backwards, the angular contraction having been remedied; in the centre of the end of the femur and the head of the tibia, two letters (x and z) are placed to designate the axis of each bony head, beneath and above which the joint has formed its abnormal axis; the arrows are placed in such a direction as the bones would take in resuming their normal position; it will readily be seen that any instrument capable of acting in the mechanical directions shown by the arrows, would accom-

plish, not only the restoration of the joint, but extend, if contracted, the extremities of the femur and tibia.

Fig. 50 (1) represents the bones replaced in their

FIG. 50.

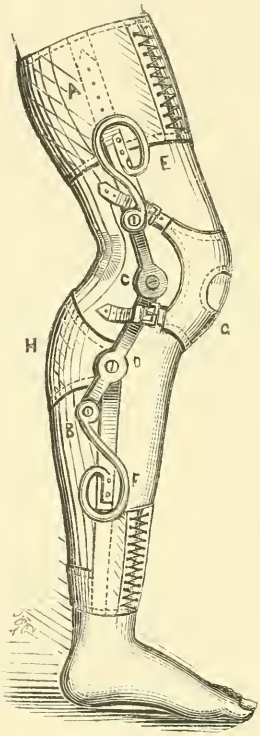


normal position, with the axis of the knee-joint restored, and each centre in its relative position.

Fig. 51 (p. 180) shows the instrument by which this restoration can be accomplished. A and B are two levers composed of metal, corresponding in their

direction to the direction of the femur and tibia; C and D are two axes, placed exactly coincident with the centres of the articular ends of the bones; E and F are two powerful springs, whose action takes

FIG. 51.



place in opposing directions, similar to the arrow indicators in Fig. 50 (2).

Thus F presses the lever (B) in an anterior direction, bearing the end of the tibia forwards, whilst E presses the lever (A) in a posterior direction,

bearing the end of the femur backwards. As C and D are found acting below the natural axis of the knee-joint, they mutually influence the point formed by the apposition of the heads of the tibia and femur; and as the femur really offers a fixed resistance, and the tibia moves beneath it, the head of the latter bone is turned anteriorly in a semi-circular direction, consequently on the upper centre (C), being a fixed point, and the lower centre (D), rotating round it. G is an elastic knee-cap and H a padded metal plate.

When the ligaments are tense, there is a chance of pressing the anterior surface of the tibia against the posterior surface of the femur; this is readily obviated by having the shaft (A) made to elongate, when the centre (C) being a little lowered, pushes the lever (B) downwards, carrying the tibia with it, and thus separating the osseous surfaces of the joint."

Respecting contraction of the toes but little need be said; it is not very frequent, and when it does occur, is generally readily reducible by means of a flat splint secured to the sole of the foot, and having interdigital slits through which an elastic strap is threaded, passing over the knuckle of the contracted toe.

CHAPTER VI.

Ankylosis—Causes—Difficulty of effecting much Improvement by Mechanical Treatment—Apparatus for producing Movement in an Ankylosed Knee—Displacement of Metatarsal Bones—Treatment—Bunion—Tight Shoes productive of Bunion—Treatment—General Paralysis—Its Treatment—Case of Paralysis of One Leg—Varicose Veins—Their Treatment by Means of Elastic Fabrics—Splint for fixing the Knee-joint—Instrument for Fractured Patella—Fracture Cradle—Instrument for Disunited Fracture of the Leg Bones.

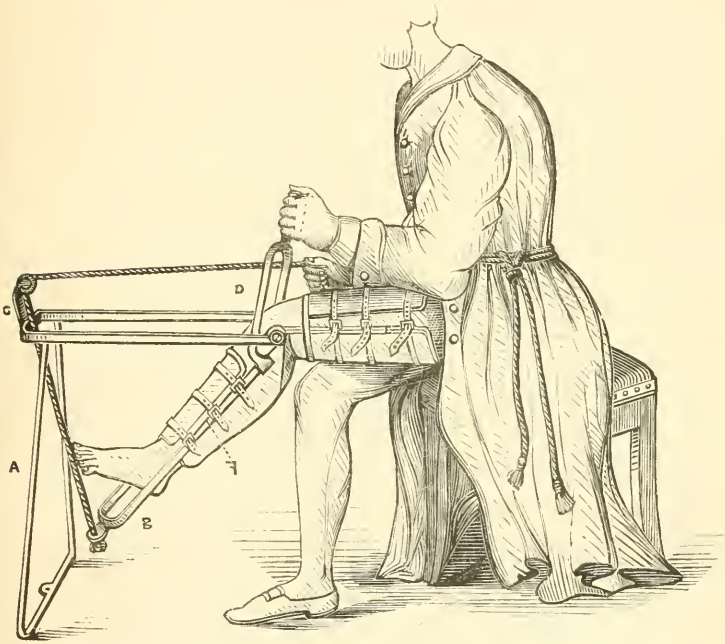
The deformity called ankylosis is one which barely comes within the pale of mechanical therapeutics, as it really admits of but very slight alleviation by mechanical means. It is caused, as has been before stated, by external injuries to the joint, strumous disease in its immediate neighbourhood, or anything which tends to produce inflammation of the structures forming and surrounding the articulation. It consists of rigid retention of the limb in one position, which may be either that of extension, flexion, or semi-flexion, but is most frequently the last.

The principal part of the treatment of ankylosis lies within the domain of surgery; I shall therefore only insert one illustration (Fig. 52) typical of

the principle upon which all instruments of the kind are constructed.

The object of mechanical treatment in ankylosis is to produce mobility of the joint; if this be effected in the slightest degree, the great object

Fig. 52.



is gained, and the further treatment will, in all probability, progress satisfactorily.

The apparatus shown (Fig. 52) is used for ankylosis or severe contraction of the knee-joint in the semi-flexed position; the frame (A) is firmly secured to the ground, and the leg and thigh in

troughs prepared for their reception. Efforts are then made to effect movement of the knee by alternately pulling the rope passing over the pulley (C) and pushing the handle (D). The constant and persevering application of this apparatus for as long a time daily as can be conveniently borne frequently overcomes the lesions which have been formed, and sets the joint at liberty; but unless the patient assists the treatment by the constant voluntary exercise of the muscles in the attempt to flex and extend the leg, little hope can be held out to him of recovery.

Every apparatus for ankylosis is constructed on a somewhat similar plan, although differing in detail; it will not, therefore, be necessary to describe them; many of the better kinds have quadrants, by means of which the amount of mobility obtained each day may be ascertained and registered; but this is not very material. The mechanical treatment of ankylosis is one of the least satisfactory branches of orthopædy, and it is to be regretted that more attention has not been paid to it.

Displacement of the metatarsal bones I have found to be a rather common deformity, especially downward displacement of the head of the metatarsal bone of the great toe; it is very easily remedied by a plan which I am not aware has been adopted by any other mechanician, but which I

have found to be invariably successful. A depression is made in the sole of an ordinary boot corresponding in size with the protuberance formed by the sinking of the bone, and nearly filling the cavity with rubber wads, adding a thin layer occasionally as the cure progresses. The elastic pressure exercised in walking raises the bone, without injury to the surface of the foot, and in a short time the necessary contraction of the ligaments of the metatarso-phalangeal articulation takes place, and the foot is restored to its normal condition.

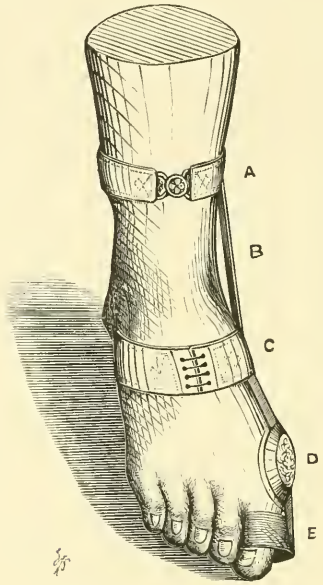
A bunion is a deformity incident to the great and little toes, and is produced for the most part by the absurd habit of wearing boots much too narrow in the tread, or sole, with the idea that they improve the appearance of the feet. Really, however, they force all the toes in a heap, as it were, and cause the metatarso-phalangeal articulations to gape outwardly by extension of the external lateral ligaments.

If people would give up the notion that by art they could improve the appearance of a naturally well-formed foot, and have lasts made to the shape of their feet, to be kept by the shoemaker for their own especial use, bunions and severe corns would not only become less frequent, but would almost entirely disappear.

The best remedy for this unsightly and incon-

venient distortion is seen (Fig. 53). It consists of a steel lever (B) secured to the ankle and instep by padded bands (A C), and embracing the extruded bone by means of an annular ring (D), bevelled on its edges, so as to fit accurately the surrounding parts. From this annulus projects a spring (E) of

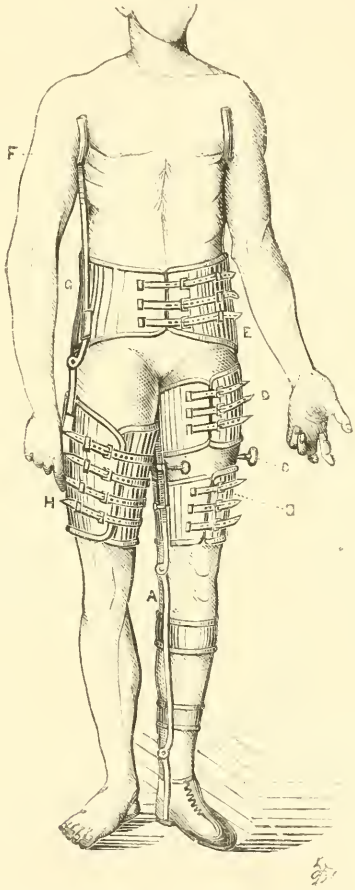
Fig. 53.



moderate power, to the extremity of which, coincident with that of the toe, the latter is drawn by means of a light band; the splint is kept in position by a rubber band extending from A to C. Anything in the shape of corn or bunion plasters, though it may afford present comfort, only serves even-

tually to increase the deformity by causing the already widened edges of the articulation to separate still farther.

Fig. 54.



In cases of severe paralysis of the whole frame, all that can be done mechanically is to afford support, and to take the weight of the trunk and

upper extremities from the limbs, transferring it directly to the ground. This is effected by fixing a lateral leg-stem (Fig. 54, A) on each side of the foot, carrying it on the inner side as high as the top of the thigh; on the outer, to the arm-pit. Free joints are placed opposite the hip, knee, and ankle, and the apparatus is secured to the body by abdominal, thigh, and calf bands (E, D, B). A rack and pinion arrangement (C) is placed on the thigh-shafts, to allow of the body being slightly lifted, so as to relieve the limbs of its weight. The engraving (Fig. 54) shows the apparatus as applied to paralysis of the left side only, in which case the leg-stems are dispensed with on the unaffected side, the crutch (C) rising from a socket in the thigh-band (H).

This mode of treatment, in common with all others, is not very satisfactory, but it enables the patient to accomplish some degree of locomotion, and to support the weight of his body with less inconvenience. It is much more used in France than in England, and is described by M. Charrierre, from whose book the diagram is copied.

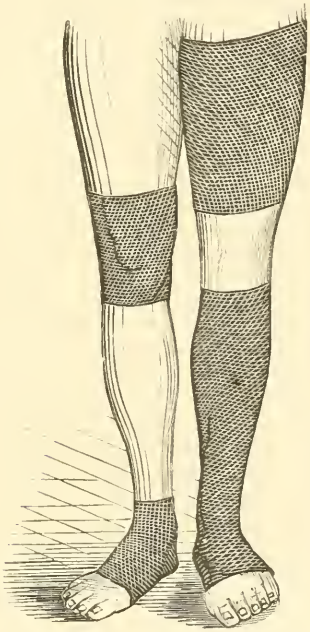
Occasionally paralysis of a limb occurs in conjunction with deformity. A very severe case of this kind is seen (Plate XIX.), in which the deformity was rather anomalous, somewhat resembling talipes varus. The deformity was easily rectified, as will be obvious from reference to Plate XX.,

PLATE XIX

which is from a photograph taken eighteen months after the first (Plate XIX.); but the paralysis was so complete that the limb was perfectly useless.

Varicose veins are rather a debility than a deformity. They consist of great swelling and sometimes even of rupture of the veins of the lower

Fig. 55.



extremities, and are productive of very great pain and inconvenience. The affection may be local and confined to one particular region, or may extend to the whole limb. For its relief elastic fabrics are used. Sometimes the ordinary Churton's bandage

is employed, being wrapped tightly round the affected part as a roller, but this yields with advantage to the use of elastic stockings, owing to the greater equability of the pressure they exert, a point of very great importance, for if the pressure be unequal, the veins beneath the parts where it is tightest are compressed, and their contents forced into the already too distended vessels beneath the looser parts of the stocking, thus aggravating the complaint. These stockings are made of silk and cotton elastic, and should be suited exactly to the shape of the leg, being made a shade smaller in every part than the limb, in order that the necessary pressure may be exerted. A glance at the woodcut (Fig. 55) page 189, will show the manner of their application.

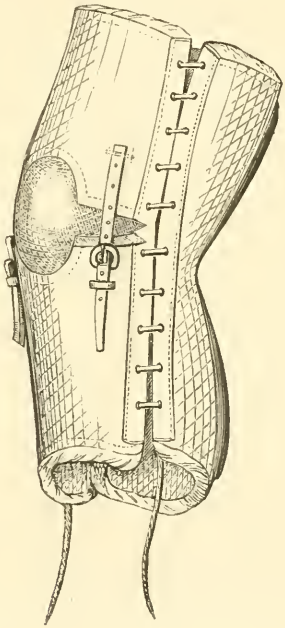
Splints and apparatus for fracture fall naturally within the scope of this work; the recognised types are universally known among surgeons, and various modifications are constantly being made to suit the requirements of special cases, thus rendering a description of them of no permanent value, I have not thought it needful to do more than mention them, particularly describing only four appliances, which I consider specially worthy of notice.

Two of these are intended for treatment of fracture of the patella, as well as for any case in which

PLATE XX

the surgeon requires immobility of the knee-joint. The first (Fig. 56) is simply made of gutta-percha, blocked to the shape of the knee and softly padded; it is laced at the sides, and a circular space cut out to avoid pressing upon the patella; this

Fig. 56.

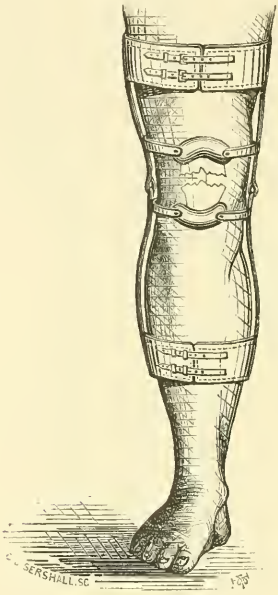


"case" retains the limb in its proper position without the slightest possibility of motion.

Fig. 57 represents another instrument for the same purpose, described by Mr. Bigg. It consists of two padded bands, one of which encircles the

thigh a few inches above the knee, the other the leg at the rising of the calf; steel shafts connect these bands on each side, and springs are so arranged as to hold the fractured portions of the patella in apposition by means of two crescent-

Fig. 57.



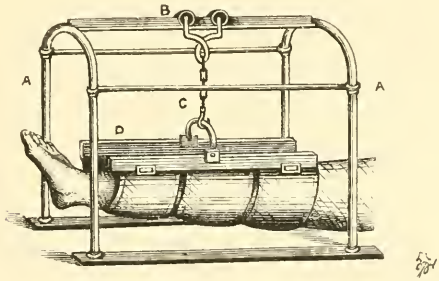
shaped pads, one pressing downwards, the other upwards, as shown in the drawing.

Fig. 58 (p. 193) is a simple cradle or swing for a fractured limb, and is introduced because it is at once the simplest and the best appliance of the kind in use wherever the leg may require protection from

the pressure of the bedclothes, or, in cases of fracture, change of position without the risk of displacing the bones. A A is a frame resting upon the bed, and having on its central bar a small railway, so to speak, upon which travel two pulleys (B), suspending by a chain (C) a soft hammock (D), upon which the wounded limb is placed, and perfectly protected from all external pressure.

I construct an apparatus for disunited fracture of the leg bones, in which the fractured ends over-

Fig. 58.



lap, and have found it very serviceable; it consists of two metal shafts riveted to a boot, and ascending to the leg, one on either side, as high as the middle of the thigh, where a strong, broad, and tolerably tight band grasps the thigh for nearly a third of its length. The shafts are hinged at the knee and ankle, and the apparatus is securely fixed to the leg; between the joints are rack and pinion arrangements, by means of which the shafts of the instrument are slightly

lengthened in excess of the leg measure, so as to transmit the weight of the body to the ground by them instead of the leg bones, thus entirely relieving them from the pressure which otherwise they would have in sustaining the weight of the body.

APPENDIX.

Correspondence.

No. 1.

Windermere, 8th February, 1858.

Mr. Salt applied steel instruments for the use of my daughter, aged two years and a half, in July, 1856. She was suffering from weakness and curvature of the ankle bones, and by persevering in the use of the instruments for the space of nine months, a complete cure has been effected.

C. Claydon Lowndes, M.A.,
Incumbent of St. Mary's, Windermere, and Tutor at Windermere College.

No. 2.

22, Bull Street, Birmingham,
4th February, 1858.

Sir,—I hereby testify to the care and attention bestowed upon my son by you, in the treatment of his legs and feet. I am enabled to state that notwithstanding the case was of the most distressing character, he is now quite restored, being able to dispense altogether with the instruments supplied to him by you.

Thomas Allday.

To Mr. Salt.

No. 3.

Acock's Green, January 9, 1866.

Dear Sir,—In reference to the great benefit performed by your skill and unremitting attention to my son's feet, my gratitude will ever continue, and no one would believe, unless they had seen it, that such a miracle could have been performed.

I remain, Sir, respectfully,

Thomas Allday.

To Mr. Salt, 21, Bull Street.

No. 4.

Mrs. Swinton presents her compliments to Mr. Salt, and begs to say, she has much pleasure in bearing testimony to his skill and judgment in the treatment of deformed limbs. Her little boy has been able to leave off the instruments for some months, his legs being nearly straight, and much stronger.

Ardglass, County Down, Ireland.

No. 5.

Brades, February 4, 1858.

Sir,—I am happy to say that, after wearing the instruments you made my son about nine months, he was perfectly cured.

Jabez Morris.

Mr. T. P. Salt.

No. 6.

Dixon's Green, Dudley.

Sir,—I have great pleasure in informing you that my child is now as straight as any of my family. I thought she would have been a cripple for life, but thanks to your skill, she is perfectly restored.

James Vicken.

Mr. T. P. Salt.

No. 7.

Upper Gornal, February 3, 1858.

Dear Sir,—I have much pleasure in stating that my child's legs were nearly straight after wearing the instruments twelve months; she can now walk very well.

Yours respectfully,

Richard Marsh.

Mr. T. P. Salt.

No. 8.

Smethwick (Cross Street),
February 2, 1858.

SIR,—We think the instruments you made for my little girl's legs have been the means of preventing her from being a complete cripple; she is still unable to do without them on account of weakness in her ankles.

Yours truly,

B. FLETCHER.

To Mr. T. P. Salt.

No. 9.

227, Cromwell Street, Birmingham,
February 3, 1858.

SIR,—After wearing the instruments which you made for my little girl about six months, her legs were completely restored; she is now quite upright.

WILLIAM THORNEWELL.

To Mr. T. P. Salt.

No. 10.

Bromsgrove, February 2, 1858.

SIR,—Had not my child been supplied with the instruments for her legs, she must have been a cripple all her life. We are thankful to you, and to the kind friends who provided them for us.

Yours most gratefully,

JOHN H. YATES.

Mr. T. P. Salt.

No. 11.

Six Ashes, February, 1858.

SIR,—When I brought my child to you, his ankle bone was upon the ground, and his toes turned inward. His foot is now flat and straight, and I think, in a little time, he will be perfectly recovered.

Yours respectfully,

EDWARD FENN.

Mr. T. P. Salt.

No. 12.

Hinckley, Leicestershire,
February, 1858.

SIR,—I am happy to say, that with the use of the instruments supplied by you to my child, and by the occasional rubbing of his legs, they are now quite straight and strong.

Yours respectfully,
E. C. BALLY.

Mr. T. P. Salt.

No. 13.

Whitnash, Leamington,
29th January, 1858.

SIR,—I am happy to inform you that my child has received great benefit from the use of the supports you made for her. Her thigh, knee, and ankle bones have become straighter and stronger, and I doubt not, if I could afford another set, or the repairing of her present supports, that she would in a few months become as straight and as well as her sister.

Your obedient servant,
ELIZA BADFORD.

Mr. T. P. Salt.

No. 14.

Lower Gornal, January 29, 1858.

SIR,—The leg instruments quite answered my expectations; they enabled my little girl to walk well.

Your obedient servant,
E. P. CARTWRIGHT.

Mr. T. P. Salt.

No. 15.

State Fire Insurance Office,
Derby, January 27, 1858.

SIR,—It is with much pleasure I inform you that your treatment of my little girl's legs has been completely successful. Her knees, which before the irons were made nearly touched each other, are now in their proper position, and her legs are as Nature intended them to be. She can run about as well as any child of

her age, and I believe the cure was accomplished without the slightest pain.

Yours respectfully,

WILLIAM PEACH.

To Mr. T. P. Salt.

No. 16.

Park Street, Wednesbury,
February 15, 1858.

SIR,—I am happy to inform you that the little girl I brought to you in the year 1855, unable to walk, or to bear the weight of her own body, on account of weak legs and ankles, has completely recovered her strength, and walks well, through the use of the leg instruments you made for her, to the great gratification of her parents and of all who knew her.

Yours respectfully,

ROBERT GRIFFITHS.

To Mr. T. P. Salt.

No. 17.

West Bromwith,
February 3, 1858.

SIR,—We believe the instruments you made for our little boy were of considerable benefit.

Yours, &c.,

JAMES ALLEN.

To Mr. T. P. Salt.

No. 18.

Brownhills, February 19, 1866

SIR,—I am happy to say that the child is very nearly straight.

Yours truly,

ROBERT JACKSON.

To Mr. T. P. Salt.

GLOSSARY.

Ankylosis, stiff joint.

Articular-surface, the opposing surfaces of any two bones forming a joint.

Amphiarthrosis, mixed articulation, that is, one capable of limited motion in every direction.

Arthrodia, gliding joint, articulation of two plane surfaces of bone.

Atlo-axoid joint, articulation between the atlas and axis.

Abduction, turning outwards.

Adduction, turning inwards.

Axis, the second vertebra of the neck.

Acetabulum, the cavity of the hip bone, which receives the head of the femur.

Astragalus, the ankle bone.

Adductor pollicis, a muscle of the foot.

Atrophied, wasted

Abductor minimi digiti, a muscle of the foot.

Aponeurosis, expansion of a tendon or tendons into a fibrous membrane.

Clubfoot, a deformity of the foot, usually inversion.

Congenital, occurring before birth.

Cicatrix, the scar of a healed wound.

Contracted joint, a joint in which, by contraction of the flexor tendons, complete extension is prevented.

Cartilage, a substance designed to lessen the force of concussion, and to facilitate the gliding of bones over each other.

Cancellous tissue, the open tissue forming the interior of bone.
Circumduction, the circular movement of a limb.
Carpus, the bones forming the wrist.
Condyles, prominences of some bones, at their articular extremities.
Calcaneum, the heel bone.
Cuboid, the chief bone in the arch of the instep.
Cuneiform bones, the three wedge-shaped bones of the instep.
Capsular ligament, a kind of ligamentous bag surrounding every articulation and containing the synovia.
Cruræus muscle, a muscle of the thigh.
Crest of ilium, the prominence of the hip bone.

Diarthrosis, moveable articulation.
Dorsum, the upper surface of the hand or foot.

Enarthrosis, ball and socket joint.
Extension, the act of straightening a limb.
Extensor longus digitorum, the muscle of the leg which extends the phalanges.
Extensor brevis digitorum, a muscle of the foot, with the like office.
Extensor proprius pollicis, a muscle extending the great toe.

Fulcrum, a fixed point on which a lever turns.
Fibula, the outer and smaller bone of the leg.
Fasciæ, membranous layers subjacent to the skin, and also investing the muscles and forming their sheaths.
Flexion, the act of bending a limb.
Femur, the thigh bone, the longest bone in the skeleton.
Flexor longus digitorum, the long flexor muscle of the toe.
Facet, small circumscribed surfaces of bones.
Flexor brevis minimi digiti, short flexor of the little toe.
Fasciculi, bundles of muscular fibre.
Fibril, the slender filaments forming contractile muscular tissue.

Genu Valgum, the deformity vulgarly called in-knee or knock-knee.
Genu Extrorsum, outward deflection of the knee.

Ginglymoid, a joint resembling a hinge in regard to its motion.
Gastrocnemius, a strong extensor muscle of the tarsus.
Gluteal region, the region surrounding the hip.

Humerus, the bone extending from the shoulder to the elbow.

Interosseous, situated between bones.
Ischiatic bones, the hip bones.
Ilium, a projection of the hip bone.
Ischium, a part of the pelvic bone.

Klumpfüss, club-foot.

Ligament, an elastic membranous substance connecting the contiguous surface of bones.
Lymph, a fluid found in the lymphatic vessels.
Lamellæ, part of the internal structure of bone.
Lever, an instrument used for applying force.
Luxation, dislocation.

Mechanical therapeutics, the mechanical treatment of deformity.
Myology, the study of the muscular system.
Metatarsal bones, five long bones in the front of the foot.
Medullary canal, the hollow spaces in the centre of long bones.
Metacarpal, belonging to the back of the hand.
Malleolus, the lower expansion of the tibia or fibula.
Medio-tarsal joint, the articulation between the astragalus and calcaneum, and the scaphoid and cuboid bones.

Non-congenital, occurring after birth.
Navicular, boat-shaped, applied to the scaphoid bone.

Orthopædy, the treatment of deformity.
Osteology, the study of the bones.
Os innominatum, the hip and pelvic bone.
Odontoid, tooth-like.
Os calcis, the heel bone; the calcaneum.

Phalanges, the toes or fingers.

Pubic bones, the pelvic bones.
Periosteum, a membrane covering the surfaces of bones.
Pubic symphysis, the point whence the ossification of the pubic bones commences.
Pied-bot, club-foot.
Patella, the knee-cap.
Plantar-fasciæ, the fasciæ of the sole of the foot.
Peronei muscles, three muscles of the outside of the leg.
Plantar arch, the natural arch of the sole of the foot.
Psoas muscles, two muscles of the iliac region.

Rachitis, the affection called rickets.
Radius, a bone of the forearm; a line drawn from the centre of a circle to its circumference.
Ratchet-joint, a mechanical arrangement for producing graduated motion.
Rubber-tendon, a rubber cord with a loop at each end.

Subcruræus muscle, a small muscle of the thigh.
Synarthrosis, immoveable joint.
Sacro-iliac, between the sacrum and the ilium.
Synovial membrane, a duct secreting a lubricating fluid for the joints.
Scaphoid, the boat-shaped bone of the tarsus.
Soleus, a strong muscle of the calf.
Sural muscles, the muscles of the calf.

Tibio-tarsal articulation, the ankle-joint.
Talipes equinus, uplifting of the heel.
Talipes varus, ordinary club-foot.
Talipes valgus, flattening of foot, eversion of toes, raising of heel.
Talipes valgus (*spurious*), flat-foot.
Talipes cavus, hollow-foot.
Talipes calcaneus, sinking of the heel.
Talipes, generic name for pedal distortion.
Tangential screw, ratchet-joint arrangement.
Tensor vaginæ femoris, a muscle of the knee.
Therapeutics, the treatment of disease.
Tenotomy, divisions of tendons for the cure of deformity.

Tendo Achillis, the tendon of the gastrocnemius and soleus muscles.
Tarsal bones, the bones of the instep.
Tendons, the terminations of muscles.
Tibia, the inner and larger bone of the leg.
Tuberosity, a prominence on a bone.
Trochanter, a prominence on the neck of the femur.
Tibialis anticus, a muscle of the front of the leg.
Tibialis posticus, a muscle of the back of the leg.
Tarsus, the ankle.
Transversus pedis, a muscle of the sole of the foot.
Triceps, having three heads.

Ulna, a bone of the forearm.

Varus, a deformity of the foot.
Valgus, another species of deformity of the foot.
Vertebræ, the bones of the spine.
V-strap, a strap used to support the ankle.
Vastus externus muscle, a muscle of the thigh.
Vastus internus, another muscle of the same region

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